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THE U.S. MODEMS & MULTIPLEXORS MARKET

(An Investigation Of Market Growth And Segments, New Technology And Industry Standards, End-User Demand, And Competition)

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THE U.S. MODEMS & MULTIPLEXERS MARKET

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INTRODUCTION AND STUDY METHODOLOGY

Marketdata has prepared the following business information report with the manufacturer, distributor/retailer, consultant, merger/acquisition candidate, and industry analyst in mind. Only the most pertinent and up-to-date information about modems and multiplexors has been used. The study covers marketing, economic, technological, and financial aspects, and draws upon a wide variety of public and private sector information sources.

The reader will be able to utilize this report as a comprehensive planning and analytical tool, gaining insight into the industry's past, current and projected performance, growth, structure, strengths and challenges. Information is both **qualitative** and **quantitative**, and will be useful for the long-established manufacturer as well as first-time analyst.

The Bureau of the Census and U.S. Department of Commerce classify industrial (as well as retail, wholesale and service) sectors of the economy by SIC (Standard Industrial Classification) codes. The production of modems and digital multiplexors is not considered an **industry** in itself. Rather, it is a specific **segment** of the total telephone apparatus and computer peripheral equipment markets. Therefore, no "economic" ratios are available for manufacturing plants producing these devices.

However, sales (dollars and units) information **is** available, via two separate SIC codes: SIC 35732 (modems-data sets, and digital multiplexors)--contained within Current Industrial Report MA 35R (Computers, Office & Accounting Machines) and SIC 36612 72-78 (modems)--contained within Current Industrial Report MA 36N (Selected Electronic & Associated Products). To arrive at the size of the market, figures from these two reports were added together. The Commerce Department plans to consolidate figures in one report in the future. This "raw data" has been painstakingly collected and analyzed, in order to determine growth patterns and to identify market segments.

Sales figures in the Market section are based on these Government surveys, and represent **sales at the MANUFACTURING/PRODUCER level**--value as it leaves the factory. Final price or value at retail or wholesale levels will be higher, as mark-ups are incorporated that reflect value-added services. Therefore, estimates of market size from trade journals, industry analysts, and other research firms may be substantially **higher** than these Government figures (see Computer Abstracts section).

Continued...

Marketdata strives to consult as many sources as possible, to arrive at a "consensus" figure for market size and forecasted growth. To rely on just **one or several** sources can be very misleading and inaccurate.

The following information sources were used for this report..........

* Bureau of Labor Statistics-Producer Price Indexes (annual, monthly)
* Dept. of Commerce, County Business Patterns
* Dept. of Commerce Exports, by Product, by Country of Destination, and Imports by Product, by Country of Origin publications
* Current Industrial Reports (annual editions-Computers & office Equipment, Electronic & Associated Products, Communications Equip.)
* Dun & Bradstreet directories
* Standard & Poors directories, stock sheets
* Manufacturers' product catalogs and advertisements
* Trade Associations
* Dialog/Lockheed Predicast Database--U.S. Forecasts file
* Trade Journals/Magazines: Electronics, Electronic News, Telephony, Telecommunications, Telephone Engineer & Management, Appliance, Business Week, etc. (and their editorial staffs)
* Thomas' Register
* Marketdata proprietary files and databases
* Special one-time reports by various consulting/research organizations

SUMMARY OF MODEM TYPES, FEATURES & APPLICATIONS

Modems are essentially computer peripheral devices that allow computers to communicate with each other over the phone lines. They are classified by the speed at which they transmit data, expressed as "bps" (bits per second). Users can now choose from units operating at speeds ranging from 300 bps to 9600 bps, or higher.

The terms *bits per second* and *baud* are often used interchangeably. Bits per second refers to the number of data bits received from the terminal and transmitted; baud is the measure of the number of modulations per second performed by the modem.

300 bps is now very outdated and virtually obsolete. Already, 9600 bps units are available for under $2,000, and a modem costing less than $1,500 that can communicate at nearly 19,200 bps over standard phone lines has recently been introduced. There is a definite speed "trade-off". Since one can only type or read so fast, standard 300/1200 bps modems are adequate for applications like calling a bulletin board system, reading electronic mail, or entering information into a remote database.

Until the 1984 divestiture of AT & T, most modems followed the Bell standards for communication protocols; the Bell 103 and 212A protocols remain dominant for 300 and 1200 bps, respectively. After divestiture, when the 2400-bps modem came into existence, producers more or less universally adopted the only available standard: CCITT V.22 bis, from the Consultative Committee on International Telegraph and Telephone, an international communications organization. At higher transmission rates, no single protocol rules.

At high transmission rates the MNP (Microcom Network Protocol) is earning a place for itself. MNP varies data block sizes according to the conditions of the line and improves throughput with data compression.

Inevitably, there is "noise" on telephone lines. So, error-corrrection features must be built into the modems. Well-designed devices can keep transmission at or near peak levels even over noisy phone lines by filtering out and detecting and counteracting signal distortions. *Throughput*--how much data gets through in a given time--is a better measure of modem speed than an advertised bps rate.

Other modem features include the following.........a **modem server**--software or hardware that allows several computers on a network to share a single modem. Modems can also lower overhead and increase throughput by using **selective re-transmission**--resending only those blocks of data that included an error. Features like **autodialing, autoanswer, self-testing** on start-up, and **LEDs** to tell you how communications are proceeding have become standard on microprocessor-controlled modems. Other features may include: **security facilities, password protection, or callback systems** that guarantee that access is granted only to systems located at authorized phone numbers, **"capture"** (for saving incoming data on a disk), **file transfer**, and **on-screen user help files** for viewing files on a computer disk.

The trend toward higher modem speeds is being accompanied by rapidly declining modem prices, driven down by competition and product standardization. Modems, no matter how highly standardized, differ from brand to brand according to their ability to compensate for line noise. As the President of Racal-Vadic explains......"Around 1980 the market blossomed for 1200 bps modems, but the world now wants to go faster.......As modem speed increases, error rates escalate, and the need for error control increases tremendously."

Acoustic modems are making a comeback in the market, due to the growing numbers of users of portable and laptop computers (such as sales reps, consultants, technicians, etc.). These people often download orders or report data to a home-office computer, or access a central database from pay phones or other locations which may lack RJ11 phone jacks. The principal problem that affected earlier acoustic modems was the poor quality of telephone microphones, now being gradually eliminated as more modern phones are installed.

EMERGING STANDARDS AND FUTURE TECHNOLOGIES AFFECTING THE MARKET

ELECTRONIC MAIL

There now exist quite a few public electronic mail services, such as MCI's service, Western Union, ITT, GTE, The Source, CompuServe, and others. The problem with no solution as yet is the interconnection of competing services. Some standards for message transfer between the services need to be developed.

For E-mail or database use, 300 baud is too slow, but the advantages of moving above 1200 baud are confused by the lack of hardware and software standards. An estimated 1.5 million office workers now use internal E-mail, with another 900,000 people using public E-mail networks. Although there is some duplication in these figures, they still illustrate that over 2 million people use electronic mail. Experts expect very rapid growth at least out to the next 10 years.

LANs (Local Area Networks)

While the benefits of electronic mail are impressive, those of local area networks are even greater. The first problem for LANs was bugs in the hardware and software, but this has more or less been solved. Then came the need to establish a base of applications programs that work properly across a network. This obstacle is being solved more slowly, but it is being addressed.

The final problem is a sociological one. For example, how is a LAN controlled on a daily basis ? If there are 10-15 people in a network cluster, who makes sure that the data being shared is valid, that it's backed up and updated ? If the system gets fouled up, who is in charge of getting it working again ?

Electronic mail and LANs are not an either/or communications decision. Many companies use a combination of the two, with gateways connecting them.

Several large companies have created custom-made private networks. Westinghouse Electric has perhaps the largest and most sophisticated system. It consists of several interconnected voice and data networks linking 1,500 locations in 17 nations. The company spends about $85 million per year on communications. According to the Wall Street Journal (Feb. 24, 1986) employees at Westinghouse can exchange electronic mail worldwide, call for recorded phone messages when out of the office, or tie into the firm's supercomputers in Pittsburgh. Some employees have PCs at home that can link up with the network over regular phone lines.

Large Westinghouse customers such as Pacific Gas & Electric, Carolina Power & Light, and Houston Light & Power can punch in orders for replacement parts, and orders are transmitted over leased lines to Westinghouse.

Other companies setting up networks include: Wal-Mart Stores, Inc., Atlantic Richfield Co. (exploration ships gather data on offshore deposits, beam findings by satellite to computers in Texas for instant analysis), Ryder System Inc. (customers keep track of shipments by tapping in from any PC to Ryder's big computer in Salt Lake City), Pratt & Whitney (videoconferencing between West Palm Beach, FL and Connecticut and Canadian engineers).

TeleStrategies Inc., a McLean, Virginia market research firm, estimates that about 30% of the Fortune 500 companies bypass local phone companies to some degree. Within two years, they expect 70% to do so, believing that any firm spending more than $1 million annually on communications can save by forming its own private network.

FUTURE TECHNOLOGIES

DIRECT BROADCAST FROM SATELLITES

This is the most far-flung technology--direct broadcast to personal computers from communication satellites. There are now dozens of satellites in orbit, with the continental U.S. included in their "footprints". The cost of using these satellites was once prohibitive but now there is an oversupply of transponsders and channels, and at the same time the cost for satellite dishes for receiving and transmitting data is falling rapidly. The speeds of transmission in direct satellite broadcast links are 9600 to 19,200 bps in most current applications.

VERTICAL BLANKING INTERVAL TECHNOLOGY

VBI technology involves recapturing an unused portion of a television signal for transmission of data. Among its uses, scheduled to begin sometime in late 1986, will be a nationwide transmission of stock market and other financial information directly from the trading floor to the personal computer. Other applications for the VBI system might include providing captioning for hearing-impaired viewers or foreign language subtitles.

THE ISDN STANDARD

The ISDN (Integrated Services Digital Network) standard is now under development. This system would take advantage of the incresed conversion of telephone circuits from analog to digital signals, allowing for easier use of phones as carriers of high-speed, unmodulated digital signals of computers and other information devices. This presents a threat to modem makers, since there is no need for a modem when signals do not require the modulation from digital to analog and back.

However, right now ISDN is a *concept*, not a concrete, existing product. Hayes Microcomputer Products, one of the leading manufacturers, expects the conversion process of the entire network to take 10 years or more in the United States, although by 1988 small "islands of service" will exist in areas with a high concentration of digital service users. But, it does remain a significant long-term issue that modem manufacturers will have to deal with, from a technology and strategic planning standpoint.

OVERVIEW AND EXECUTIVE SUMMARY

The tremendous growth of personal computer usage over the past 5-10 years, both in Fortune 500 companies as well as by small businesses and at-home computer users, has created a huge market for "peripheral" devices that expand capabilities of the core system. These devices include computer printers, hard disk drives for expanding memory, computer furniture, supplies and protective equipment, and many other products. But, the most popularly-purchased "add-on" device, according to a recent PC magazine survey, is the **modem**--which enables computers to "talk" to each other by sending/receiving voice and data over the phone lines.

Modems open up a whole new world of communications for computer users, allowing them to access commercial information databases from their home or office, and linking various business locations together, thereby improving efficiency and productivity. A close cousin of the modem is the **multiplexer,** a device incorporated into telecommunications networks, which enhance or in some cases substitute the functions of a modem.

Like so many other electronic equipment markets, this market is maturing in response to changing end-user requirements, is characterized by stiff competition from a host of producers, has shifting market segments, and faces several major technology issues in the near future. Corporate America wants to work and communicate faster and more productively. Hence the proliferation of "intelligent" typewriters, facsimile machines, personal dictation machines, and supercomputers that work at ultra-high speeds. Modems are no exception to this overall trend. The fastest-growing segment of the modems market are the 2400, 4800 and 9600 bits-per-second (bps) devices. Units that transmit at slower speeds (300-2400 bps) still appeal to some buyers, but this line faces a smaller share of the total market in the future.

THE MARKET..............

THE MODEMS MARKET

Combined, the market for modems and multiplexers is estimated to be worth $2 billion in 1987, at the manufacturing level. Marketdata estimates that modem sales will be worth $1.4 billion this year, growing 27% between 1985 and 1987. Sales grew at a 10.8% average annual pace from 1980-85, and have increased every year since 1974, except for a 1.5% decline in 1985. We estimate that in excess of 2 million units will be shipped in 1987, and forecast the market to advance 11.3% yearly over the next five years, reaching $2.18 billion by 1992.

Classified by modem transmission speed, following are sizes of the estimated 1987 **market segments**, their share of the total, and the outlook for 1992.............

* **2000-4800 bps modems** are estimated to account for a $635 million in 1987 sales, or 45.5% of the total modem market. Sales from 1987-1992 are forecast to rise 7.5% yearly, reaching nearly $873 million and representing 40% of the market, a slight decline in share.

* **4800 + bps modems** are estimated to be a $480 million 1987 market, 34.4% of the total. Sales of this segment are expected to increase 18.6% yearly through 1992, reaching $927 million and accounting for the largest share of the market--42.5%.

* The **300-2000 bps modem** area is estimated to be worth $253 million in 1987, and to grow 7.6% annually to $349 million by 1992. This segment will account for 18% of the total 1987 market, forecast to fall to 16% by 1992.

* Modems **up to 300 bps** speed, the slowest devices, are declining in importance, estimated to be worth $28 million in 1987 shipments and representing only 2% of the total market. Sales of this line are expected to gain only 3.5% yearly, to $32.7 million by 1992 and represent 1.5% of the market.

Acoustic modems are staging a comeback in the market, fueled by demand from growing numbers of portable and laptop computer users (sales reps, technicians, consultants operating in the field). With these devices, they can access a headquarters computer or central database from pay phones.

The Digital Multiplexer Market.........is estimated to reach $607 million in 1987, at the U.S. manufacturer level. This market increased from a volume of $155 million in 1977 to $496 million by 1985, and is estimated to have grown 22% between 1985 and 1987. Marketdata forecasts sales to advance at a 15% average annual pace over the next five years, hitting $1.062 billion by 1992.

About 83% of the multiplexer market (in dollars) is accounted for by **statistical** multiplexers, versus 17% for **time division** devices. The fast-growth "specialty" segment is the so-called " **T-1** " devices area, expected to eventually surpass statistical multiplexers and more traditional equipment. This T-1 area is expected (by International Data Corp.) to generate $340 million in sales in 1987 and rise to a majority of 58% of the total market by 1990. T-1 devices play a central role in the networking equipment market, spurred on by the Bell break-up which led corporations to take on more responsibility for network management. Due to its fast growth, the T-1 business is attracting a growing list of competitors.

EXPORT MARKETS & IMPORT COMPETITION

Exact figures concerning exports of modems and multiplexers **only** are not available, but are combined with other devices in a Commerce Department category termed "digital & analog communications carrier equipment". Since 1979, exports of this equipment by U.S. producers have risen 25% annually, on average, from $296 to $829 million by 1986. In addition, total data communications equipment markets in five nations (Japan, W. Germany, England, France, Italy) are estimated to be worth a combined $1.057 billion in 1987. The fastest-growing market from 1985-87 is the United Kingdom, 24% per year. A **share** of this market, which we are unable to determine, is applicable to modems/multiplexers. Consequently, the exact market potential overseas is not known, but the broader market of which modems are a part is on a strong uptrend. And, with the dollar's decline in international markets U.S. products are becoming more competitive.

Import penetration of this market doesn't appear as extensive as in other electronics businesses. Again, dollar volume is not known, but Marketdata estimates that it does not exceed 10-20% of the market. The two most noticeable competitors are **NEC America and Fujitsu America**. Technically speaking, Racal Electronics is a British company and could be considered an overseas competitor. But, since Racal-Milgo and Racal-Vadic are U.S.-based manufacturing operations we don't consider their sales as "imports".

COMPANY MARKET SHARE & RECENT PERFORMANCE - THE LEADERS

The modem/multiplexer market is extremely competitive. Judging by several trade directories such as the Electronic Design Gold Book, there are 189 total companies competing--100 in modems and another 89 in multiplexers. The leaders commonly produce **both**, with about 27% of modem producers **also** produce multiplexers.

Marketdata estimates that the top 4 companies in the combined modem and multiplexer market capture 51% of total sales, a fairly high concetration ratio. The top10 are estimated to account for 82%, and the top 13--nearly 89%. The market leaders include.........Racal-Milgo and Racal-Vadic (of Racal Electronics Plc--the two firms comprising Racal's U.S. Data Communications Div.) with 22.3% together, Hayes Microcomputer--11.0%, Paradyne Corp. with 9.1%, General DataComm Industries--8.9%, and AT & T with 8.5%.

Motorola's two subsidiaries together capture an estimated 8.3% (Codex Corp. and Universal Data Systems), and are both prominent players. Based on a 1987 survey of modem users by Datapro, AT & T, Codex, U.D.S., Paradyne, General DataComm, and Racal together represent over 72% of the **installed base** of modems. Other important manufacturers include: Gandalf Technologies, Timeplex, Rockwell Intl., Concord Data Systems, and Anderson Jacobson.

In addition, Paradyne employs 3,400 workers, Gandalf Technologies employs 1,360, and Timeplex employs 745. Comprehensive employment figures for **all** the major competitors is scarce.

Following is a brief summary of the recent performance of some of these market leaders. Results are mixed, affected by particular company situations and marketing/end-user strategies. **All** have been affected by competitive pressures that have led to steadily falling prices, a boom for buyers but not so good for producers' profit margins.

Racal's data communications group sales were up 2.6% in fiscal 1987 to $445.4 million (international-not only U.S.). Profits nearly tripled from 1986-87. Racal-Milgo's sales and profits both improved, while Racal-Vadic had a 10% sales increase and returned to profitability in the U.S.

Paradyne sales rose 3.4% and the firm reported a pre-tax loss of $37.6 million (due to the firm's legal/settlement costs associated with fraud charges and shareholder lawsuits).

General DataComm's sales fell 3.3% in 1986, after doubling from 1983-85. Net income as a percent of sales fell from 7.8% in 1984 to 2.2% by 1986.

Gandalf's sales are estimated to be up 20% in 1987, and net profit is expected to hit 4.6% of sales, with further improvement seen for 1988. It reports that **U.S.** sales are slow, but European and Canadian markets are healthy and are contributing to this strong showing.

Anderson Jacobson sales peaked at $52.8 million in 1983, but declined 16.3% in 1986. The firm incurred a loss of 3.17% of revenues.

CURRENT & FUTURE TECHNOLOGIES AND INDUSTRY STANDARDS AFFECTING THE MARKET

Overall, modem **users** report being satisfied with technology now on the market, but were **not** enthusiastic about their diagnostic capabilities. Hardware reliability was the area rated highest in user satisfaction. Modems, in addition to their declining prices, are being built with an increasing array of extra features demanded by end-users. Related software is becoming more sophisticated. Some of the most common features are.........selective re-transmission, autodialing, autoanswer, self-testing, LED readouts to monitor communications, security facilities, password protection, callback systems, file transfer, an on-screen help files.

Prior to the 1984 divestiture of AT & T, most modems followed Bell Standards for communications protocols; the Bell 103 and 212A protocols remain dormant for 300 and 1200 bps modems, respectively. After divestiture, when 2400 bps units came into existence, producers more or less universally adopted the only available standard: **CCITT V.22 bis**, from the Consultative Committee on International Telegraph & Telephones, an international communications organization. At **higher** transmission rates, no single protocol rules, although the **MNP** (Microcom Network Protocol) is earning a place.

Market analysts have recently begun predicting the demise of the analog modem market in view of the emerging **ISDN** (Integrated Services Digital Network). This system would allow for easier use of phones as carriers of high-speed digital signals of computers and other information devices. In effect, this technology would render modems obsolete. However, right now **ISDN** is a **concept** and is years, perhaps a decade or two away. Hayes Microcomputer expects this conversion process of the entire network to take 10 years or more in the U.S. But, it **does** represent a long-term threat on the horizon that modem makers will have to deal with eventually.

Other futuristic technologies that may affect this market include **direct broadcast from satellites** to personal computers. There is now an oversupply of satellite transponders and channels, and once prohibitive costs of satellite dishes that receive data are falling rapidly. **Vertical blanking interval technology** is another area. It involves recapturing an unused portion of a TV signal for transmission of data. With this system, direct transmission of financial and stock market information to PCs is possible, among other applications.

MARKET OUTLOOK AND END-USER DEMAND

There are several trends that lead Marketdata to forecast 11.3% average yearly growth in the modems market and 15% yearly gains in the multiplexer market through 1992. These include the following.........

* Over two million people are now estimated to use **Electronic Mail**, including 1.5 million office workers. This includes: MCI, ITT, The Source, Compuserve, Western Union, and others. Experts predict very rapid growth at least for the next 10 years. We agree, as workers seek to communicate faster and more reliably than the U.S. Postal System.

* The growth of **Local Area Networks** (LANs) should continue at a strong pace, with benefits to users even greater than electronic mail. Sharing of data and equipment is more cost-effective than operating in isolation, and more workers are discovering these economies of scale. More and more large companies also will create custom-made private networks that link corporate offices across the nation and worldwide. Telestrategies expects that within two years 70% of the Fortune 500 will bypass local phone companies to some degree, with any firm spending more than $1 million per year on communications a prime candidate.

* Despite periodic downturns in the personal computer market, strong growth over the next five years should continue. An increasing number of small businesses, entrepreneurs (sole proprietorships, partnerships, etc.), doctors, lawyers, and non-business consumer users are discovering computers. The advent of laser printing and desktop publishing, as well as more user-friendly software will spur sales of systems. Many users (52% on average), to get the most out of their system, will purchase modems to access remote databases, information services, perform computer banking and stock trading, and link up with suppliers providing advertising, typesetting, and other business services.

* Falling prices, coupled with an increasing number of features and built-in capabilities, should make modems more attractive to buyers. A weak dollar should make export opportunities more realistic in the short term, especially in the developed nations such as Japan and Western Europe, whose PC markets are just beginning to emerge, with associated high rates of growth.

This market is not without its challenges and obstacles, however. Sales of high-end, high-speed modems and multiplexers are still very sensitive to the health of the PABX telecommunications market (which grew **32%** in 1986 but is expected to drop to a **1%** gain this year), and cyclical, mature minicomputer and mainframe computer markets (which slowed in early 1987). Stable or falling prices expand the potential market for modems, but at the same time result in lackluster profit margins for producers. Potential product obsolescence over the long term looms in the form of the embryonic ISDN standard. Also, confusion exists in the market over standardization and compatibility between hardware and software offered by different vendors. Competition is fierce now and will worsen if Japanese firms decide to move into the market in a bigger way in the future.

To survive in the market, **small** firms especially may nave to seek out joint ventures and mergers, in technology, distribution, etc. Some of the **larger** competitors are already doing this. As of late September, Racal-Milgo and Digital Communications Associates had completed a multi-year agreement under which the companies will cooperate to develop compatibility between DCA's System 9000 T1 Multiplexer Management System and Milgo's Communications Management Series. With two technical assistance centers and 14 locations, DCA's service force is strong but limited. The agreement will expand this capability, tapping into Milgo's 300 field engineers and 400 service personnel at 140 locations. This is but one example of the increased joint-development activities we expect in this market in the future.

THE U.S. MODEMS MARKET

SUMMARY

The modems market has grown steadily since the early 1980s, in direct relation to the health of the data processing equipment and telecommunications sectors. Modems are being employed more frequently as computer "add-ons" purchased in conjunction with or after the computer system itself. They are the **most** popular peripheral device to be added. The market has been fueled by strong demand from personal computer users that access remote databases, and by users of minicomputers and technical work stations.

As in **all** markets, there is a fast-growth segment--in this case, high-speed modems (2400 bits per second and faster). As the business world seeks to communicate and transmit data faster and faster, these lines will grow, at the expense of low-speed (300, 1200, under 2400 bps) modems.

The market has also attracted a host of competitors, although the top four or five firms still capture the lion's share of sales. The intense competition has been a boom for buyers, who are offered an increasing array of new features and capabilities, as well as falling prices. For producers, however, this hurts profit margins and the ability of small firms to survive. A number of technology issues also confront producers, namely, inter-market competition from certain multiplexers and the medium-long term effects of the proposed ISDN standard. Software compatibility standards is also a problem.

ESTIMATING & FORECASTING METHODOLOGY

The sales estimates and forecasts in this section were derived from a careful analysis of information and opinions taken from Government publications (Dept. of Commerce--Current Industrial Reports, Census Bureau), the major, reputable electronics industry trade journals (Electronics, Electronic News), and industry analysts from Dataquest, Venture Development, International Data Corp., and others. The main distinction is between **government** and **private sector** market estimates. Each is valuable, but must be examined for their different survey methodolgy, market coverage, accuracy and reliability.

For example, Department of Commerce statistical reports such as the Current Industrial Reports and 5-year Census of Manufactures probably represent more comprehensive coverage of a market or industry than trade journals, since the surveys **must** be filled out by law. **Actual** sales are reported, rather than a company's **estimates** of market size reported to trade journal editors. Also, government figures do **not** include the value of **captively used** products not sold to markets external to the company (i.e. components made by IBM and incorporated into their computers, which are not sold separately on the open market). Trade journal estimates may include this captive value.

Survey sample sizes also differ. Since most trade journal editors are "generalists" that cover many markets in their research, a particular market such as modems may not be as thoroughly covered as government surveys. For example, Electronics' January 1987 "U.S. Market Report" estimated the modems market to be worth $1.65 billion in 1985, compared to the Commerce Department's figure of $1.1 billion. Which is more accurate ? An Electronics editor, when questioned about the number of firms surveyed, stated that about 200 companies were used for the ***entire*** communications equipment market. This includes not only modems, but FAX machines, radios, PABX, TV equipment, fiber optic systems, etc.--a large area. It is probable that only 20-30% of the 100 or so modem manufacturers were polled to come up with their sales estimate.

In addition, Electronics estimates **do** include the value of **imports**--not reflected in Commerce Department figures. The true size of the market therefore probably lies somewhere in between these two sources, and is the reason Marketdata uses both. Another trade journal, market research firm, or industry analyst may employ yet **another** survey method. Only by looking at **all** of these estimates can one arrive at a middle ground or "consensus" figure of the most likely market size.

MARKET SIZE & FORECASTS

Marketdata estimates that sales of modems shipped by U.S. producers will be worth about $1.4 billion in 1987, and have grown 27% since 1985's actual reported level of $1.1 billion. Modem sales volume has increased every year since 1974, with the exception of brief slowdowns in 1982 (volume stayed virtually the same), and in 1985 (-1.5%). Sales grew at a 10.8% average yearly pace from 1980-85. The market doubled in 1979, and posted 30%+ increases in five other years in the period 1974-85. **We estimate that over two million units will be shipped this year. Marketdata forecasts modem sales to advance at an 11.3% average annual rate over the next five years, reaching $2.18 billion by 1992.**

Industry generally classifies modem market segments according to the following transmission speeds........300-1200 bps, 1200-2400, 2400-4800, and 4800 and over. However, the Commerce Department sets the major categories as follows........up to 300 bps, 300-2000, 2000-4800, and over 4800 bps. We will discuss both in the following sections.

The slowest-speed modem segment, up to 300 bps, is declining in importance as the business world pushes for faster devices. This segment was worth $63.3 million in 1979, when the market was young and high-speed transmission was not as vital. Since then, sales have more or less fallen to the $30 million level by 1984-85, and are **estimated at $27.9 million for 1987, representing 2.0% of the total modems market. We expect sales to rise only 3.5% yearly, representing $32.7 million by 1992, for 1.5% of the market.**

The 300-2000 bps segment, also a slow speed by today's standards, is expected to reach **$252.9 million in 1987, and to grow 7.6% annually to $349 million by 1992. Unit** sales in 1987 should total 780,000. **This line will account for an estimated 18.1% of the total market during 1987 and fall to 16% by 1992.** Its historical share of the market from 1975-85 was 19.8%, but this will drop as the higher speed devices become more popular.

The 2000-4800 bps modem segment accounted for sales volume of $400-500 million during 1983-84, and is expected to have grown substantially since 1985 with their increased popularity. Consequently, **we expect this line to account for $635 million in sales for 1987, or 45.5% of the market. Unit** sales are expected to total 664,000 this year. **1987-1992 sales should advance at a 7.5% average yearly pace, reaching nearly $873 million and constituting 40% of the market.** Sales in the short-term will be strong, but eventually users will demand even faster modems (9600 bps and faster), leading this latter category to account for the greatest share of sales by 1992.

The "over 4800 bps" modems segment should blossom more in the longer term, in 3-5 years, as users move from the currently popular 2400 bps

Continued.............

speed to higher ones. **Marketdata estimates 1987 sales of this line to be worth $480.6 million, and to increase 18.6% yearly from 1987-1992. Unit** sales should total about 527,000 this year. **Sales volume is forecast to reach nearly $1 billion, $927 million. This segment is estimated to account for 34.4% of the total modems market in 1987 and to rise to a majority 42.5% by 1992.**

Following is a sampling of modem market forecasts by ***other*** market research firms, trade journals, and industry analysts..............

* Electronic Business forecasted microcomputer modem shipments to move more heavily into OEM channels through 1988, and pegged the market at $1.5 billion by that year.

Percent of Market	1983	1988
Direct	56 %	51 %
OEM	4	11
3rd Party	40	38

Sales, By Type Modem	1988	
Stand-Alone	$675	Mill.
Integral	375	
Board Level	450	
	1,500	

* Mini Microcomputer Magazine expects the following 1985-88 growth rates, by type modem (higher-speed devices will fare best)........

1200 bps (half-duplex)	-0.1 %
1200 " (full duplex)	14.1
2400 bps	8.1
4800 bps	8.4
9600 bps	**16.0**
14,400 bps	**31.1**
Short haul	14.0

They expect the total market to grow 22.6% per year, reaching $2.78 billion by 1988.

* Electronics forecasts the following unit production by 1991...........

300-1200 bps	485,100
1200-2400	1,262,100
2400-4800	1,262,100
4800-9600	275,100

1987 sales of $2.12 billion are segmented as follows...............

High speed modems (2400+ bps)	$1,660	Mill.
Low speed modems (under 2400)	422	
Radio frequency data modems	41	
Total:	$2,123	

* Industry Week estimated the value of the modems market at $1.3 billion in 1985, rising to $2.0 billion by 1990 (or 10.8% yearly).

* Dataquest analysts expect 2400 bps modem sales to jump from $64 million in 1986 to $642 million by 1990. Further, they expect 73% compound yearly growth through 1989 for high speed modems. They expect the total world data communications market to expand from $10.3 billion in 1984 to $21.8 billion by 1990 (16.3% annual growth). A 1986 forecast of theirs pegged the value of the market for "modems, multiplexers, front-end processors, and data network control systems", combined, at $4.127 billion by 1987, growing 21.6% yearly since 1983.

* Venture Development expects 2400 bps modems to move from one-third of the total market to a majority of sales by 1990. These are their product segment forecasts by modem speed...........

300-1200 bps modems	64.5%	of market, falling to 23.1%
2400 "	32.8,	rising to 60.1%
4800 "	2.1,	rising to 3.7%
9600 "	0.6,	rising to 13.1%

* International Data Corp. analysts predict that 400,000 2400 bps modems will be purchased in 1987, versus 170,000 during 1985, as they gain wider acceptance.

* Electronics Marketing says that sales of modems for personal computers was a $760 million market in 1985, and should increase 43.2% yearly, to $2.4 billion by 1990. They expect a total modem market of $1.7 billion in 1987, $2.7 billion by 1990 (growing 8.3% yearly from 1984-1990).

* Frost & Sullivan forecasted PC data modem sales to rise from $1.3 billion in 1984 to $2.3 billion by 1989 (15.4% average yearly rate). Personal computer usage accounts for 60% of the consumption of data modems.

MARKET OUTLOOK

As discussed in the End-User section, within the market for telecommunications equipment, voice-switching systems are due for a hard year in 1987. PABX equipment sales, which grew 32% in 1986, are expected to flatten to a 1% gain. Buyers are turing from voice-only to the latest digital PABX products, which can sen both voice and data. Racal-Milgo reported in the early part of this year that the slowdown in sales of minicomputers and mainframes is hurting sales of high-end data communications equipment such as high-speed multiplexers, modems, and network processors. A modest improvement is seen for the second half of 1987.

Many manufacturers of the low-end modems experienced intense price pressures during 1986. Producers reported as much as 60% price declines from mid-1985 to early 1987. For example, a full-duplex modem cost $1,000-1,100 in mid-1985, but one can buy a 1200 bps modem with more features **now** for about $500. **Producers' volumes have gone up, but profits are sagging** because they can't add features that would allow them to increase their margins. As further proof of this price situation, the Bureau of Labor Statistics' Producer Price Index for modems has not moved an inch from July 1986 to June 1987--staying the same at 106.4 (Dec. 1985 = 100, base year).

Modem suppliers are also looking at the advantages and negative impacts of T-1 multiplexer growth, and trying to keep pace with enhanced funtion demands of end-users. They have to prepare for possible new markets represented by the ISDN (Integrated Services Digital Network)--the telephone company concept that envisions all-digital transmission facilities. Nevertheless, traditional analog modems of all speeds for long-distance and short-haul applications are still expected to account for about 95% of the market.

As an example of this ISDN competition, AT & T is now promoting a "UNITE "ISDN family of devices. Its T7250A S/T interface chip is integrated directly into phone and computer terminals to deliver full duplex/digital capabilities, conforming to CCITT I.430 recommendations. The chip exchanges voice and data traffic at 192 Kb/s over a 4-wire digital subscriber loop. In addition, AT & T's T7112 Asynchronous Receiver/Transmitter Interface (ARTI) eliminates 95% of the software and the 3-4 logic chips normally required to handle different data rates.

MAJOR COMPETITORS

The Electronics Gold Book lists approximately 100 different modem manufacturers, but the true number is probably smaller. Commerce Department electronics industry analysts report that some **distributors** are mixed in with manufacturers, and companies that make **other** products are frequently wrongly classified. Another complaint is that these guides are not as up-to-date as they could be, and many firms, when contacted at their listed address, are found to be out of business. Many new, small firms have entered the market in recent years and turnover/business failure rates are high.

Whatever the total number, Codex Corp. (a Motorola subsidiary) and Racal-Milgo compete for the top position in the $120 million **high-speed** modems market, with Paradyne Corp. probably number two. Other major players include Racal-Vadic (Racal Electronics' other U.S. division), Hayes Microcomputer Products, Universal Data Sytems (also part of Motorola), General DataComm Industries, Rockwell International, Digi-Voice, Gandalf, and ComDesign Inc. Detailed information on many of these firms is contained in the **Company Profiles** section later on in this report.

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

U.S. MANUFACTURERS' SALES
($ THOUSANDS)

	ELECTRONIC MODEMS (ALL TYPES)	ANNUAL % CHANGE	DIGITAL MULTIPLEXERS*	ANNUAL % CHANGE
1971	$115,728 #		---	
1972	108,747 #	-6.1		
1973	69,374	---		
1974	98,622	42.1	---	
1975	111,901	13.5	---	
1976	145,471	30.0	---	
1977	171,271	17.7	---	
1978	235,185	37.3	---	
1979	516,904	119.8	191,014	82.6
1980	713,562	38.1	242,989	27.2
1981	797,920	11.8	349,159	12.0
1982	797,297	-0.1	391,212	12.0
1983	1,039,223	30.3	437,497	11.8
1984	1,117,048	7.5	491,823	12.4
1985	1,100,000**	-1.5	496,420	0.9
ESTIMATE				
1987	1,397,000	13.5 @	607,000	7.0 @
FORECAST				
1992	2,182,000	11.3 @	1,062,000	7.0 @

*** Incl. frequency-division & time-division types.**
**** Estimated by Dept. of Commerce, subject to revision**
# Modems & multiplexors sales combined
@ Average annual rate

SOURCE: U.S. DEPT. OF COMMERCE, CURRENT INDUSTRIAL REPORTS, MARKETDATA ESTIMATES & FORECASTS

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

MAJOR MARKET SEGMENTS
MANUFACTURERS' SALES, BY MODEM SPEED

($ Thousands)

	UP TO 300 B/S	301-2000 B/S	2001-4800 B/S	OVER 4800 B/S
1975	$19,423	$12,353	-----$80,125-----	
1976	20,158	17,638	----107,675----	
1977	34,062	25,017	----112,192----	
1978	41,132	50,271	----143,782----	
1979	63,314	124,726	----328,864----	
1980	51,980	206,258	----455,324----	
1981	48,818	190,113	----558,989----	
1982	31,448	167,194	343,385	255,270
1983	29,538	209,907	495,957	303,821
1984	30,920	247,517	393,257	445,354
1985	31,793*	158,497*	272,248*	398,310*
ESTIMATE **1987**	**27,900**	**252,850**	**635,650**	**480,550**
FORECAST **1992**	**32,730**	**349,120**	**872,800**	**927,350**

* 15-25% of these figures are estimated by Dept. of Commerce, and are likely to be revised upward.

SOURCE: U.S. DEPT. OF COMMERCE, CURRENT INDUSTRIAL REPORTS, MARKETDATA ESTIMATES & FORECASTS

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

MODEMS MARKET SEGMENTS - PRODUCT MIX
PERCENT OT TOTAL MARKET BY TYPE MODEM

	UP TO 300 B/S	301-2000 B/S	2001-4800 B/S	OVER 4800 B/S
1975	17.4	11	---- 71.6 ----	
1976	13.9	12.1	---- 74 ----	
1977	19.9	14.6	---- 65.5 ----	
1978	17.5	21.4	---- 61.1 ----	
1979	12.3	24.1	---- 63.6 ----	
1980	7.3	28.9	---- 63.8 ----	
1981	6.1	23.8	---- 70.1 ----	
1982	3.9	21	43.1	32
1983	2.8	20.2	31.6	46.3
1984	2.8	22.2	35.2	39.9
1985	3.7	18.4	47.7	29.2
ESTIMATE				
1987	2.0	18.1	45.5	34.4
FORECAST				
1992	1.5	16..0	40.0	42.5
HISTORICAL AVG. 1975-85	9.8	19.8	---- 70.4 ----	

SOURCE: U.S. DEPT. OF COMMERCE, MARKETDATA CALCULATIONS, ESTIMATES, FORECASTS

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

MODEMS UNIT SALES, BY TYPE/SPEED

-----------UNIT SALES (1000 SETS)-----------

	UP TO 300 B/S	301-2000 B/S	2001-4800 B/S	OVER 4800 B/S	TOTAL
1976	68	123	-------55-----		246
1977	118	61	-----57-----		236
1978	277	125	------91-----		493
1979	423	293.8	128.3	49	894.1
1980	240.4	366.6	178.7	74	859.6
1981	285.3	346.3	205.6	187	1,024.3
1982	131.3	375.8	170.3	197.4	874.8
1983	109.6	591.8	394.7	333	1,429.1
1984	144.0	631.4	295.2	347.9	1,418.5
1985	*	*	*	*	*
ESTIMATE 1987	120.0	780.0	664.4	526.9	2,091.3

*** Data on unit shipments withheld.**

SOURCE: U.S. DEPT. OF COMMERCE, CURRENT INDUSTRIAL
REPORTS, MARKETDATA ESTIMATES

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

NUMBER OF PRODUCING COMPANIES BY TYPE MODEM

	UP TO 300 B/S	300-2000 B/S	2001-4800 B/S	OVER 4800 B/S
1976	7 +	7 +	5 +	3 +
1977	10 +	8 +	6 +	4 +
1978	13	12	9	7
1979	24	22	14	12
1980	26	24	16	14
1981	24	25	17	19
1982	25	25	16	19
1983	28	26	27	27
1984	31	31	26	28
1985	31	39	31	27

NOTE: DATA HAS BEEN COMPILED FROM TWO REPORTS: MA 36N ANI MA 35R - CURRENT INDUSTRIAL REORTS. FOR 1976 AND 1977 DATA WAS NOT AVAILABLE FROM CIR MA 35R, THEREFORE FIGURES ARE EXPRESSED AS 7 + ETC.

SOURCE: U.S. DEPT. OF COMMERCE, CURRENT INDUSTRIAL REPOR

THE DIGITAL MULTIPLEXER MARKET

SUMMARY

Increasing use of wide-capacity digital transmission in telecommunications facilities is feeding demand for multiplexers. Like the modems market, multiplexer producers face pressure to further expand the diagnostic, network monitoring and other intelligent capabilities of their equipment. Competition is substantial in this market as well, and many manufacturers of four and eight-line multiplexers experienced severe price pressures during 1986. Like the modems business, new technologies are evolving and the market has its fast-growth segment, in this case--the "T-1" multiplexer. In some respects, multiplexers compete for the data communications sales dollar, while in other ways they complement the modems business and expand it.

MARKET SIZE & FORECASTS

According to the Department of Commerce, U.S. manufacturers' sales of digital multiplexers grew from $155.2 million in 1977 to $496.4 million by 1985 (a 27.5 % average annual increase). Dollar value measured **at the factory level** is always smaller than the final price to the end-user, allowing for distributor/retail mark-ups. For example, Electronics' January 1987 survey estimated that 1987 sales of multiplexers will constitute a $757 million market. International Data Corp. estimates 1987 market size at about $730 million. Nevertheless, Commerce Department data does show that the multiplexer market has grown steadily since 1979, but **dollar volume** slowed to less than 1% growth in 1985 and **unit** shipments fell nearly 15% to 268,369.

Marketdata estimates that the U.S. multiplexer market at the manufacturing level grew about 22% between 1985 and 1987, reaching $607 million. Further, we forecast dollar volume to advance at a 15% average annual pace over the next five years, hitting $1.062 billion by 1992. Early in 1987 Racal-Migo marketing personnel expected the slowdown in sales of minicomputers and mainframes to adversely affect sales of such high-end data communications products as high-speed multiplexers. They expected the slump to continue into the early part of this year, possibly with an upturn in the second half.

Like **all** markets that are dependent upon capital goods end-users (computer manufacturers) one should not forget that sales growth is still subject to swings in the overall business cycle. Even though the potential end-user base is expanding and many people are just beginning to discover the benefits and applications of computer-to-computer communications, accessing remote databases, etc. recessions/slowdowns still occur. In fact, the next one will probably take place in late 1988-early 1989, after the new administration takes over. One must remember that we are already over five years into an uninterrupted business expansion that cannot last forever. Modem and multiplexer producers, likewise, will **plan and expect** this downturn by continuing to invest in R&D, a steady stream of new products that expand their end-user base, and conservatively adding staff and facilities.

About 83% of the market (in dollars) is accounted for by **statistical** multiplexers, versus 17% for **time division** devices.

Following are International Data Corporation's estimates of the market, from 1985-1990. They show how the T-1 market will play an increasingly important role and be the fast-growth segment.

	Total Multiplexer Market ($ Millions)	T-1 Market	T-1 Sales As % Total Mkt.
1985	$500	$150	30.0
1986	620	240	38.7
1987	730	340	46.6
1988	825	430	52.1
1989	910	500	54.9
1990	1,000	580	58.0

THE T-1 MARKET

The T-1 devices area is seen as one of the fastest-growing segments of the multiplexer business. It is expected to eventually surpass statistical multiplexers and more traditional equipment. As shown above, this market is estimated to generate **$340 million in sales for manufacturers this year, and rise to a majority 58% of the total market by 1990**. Analysts at Goldman Sachs projected that T-1 multiplexer sales shot up 61% from $146 million in 1985 to $235 million in 1986.

T-1's central role in the networking market (the Bell break-up has led corporate users to take on increasing responsibility for network management) is attracting other companies. Marketdata has identified at least 122 multiplexer producers in this report (refer to directory at back of study for listing). The T-1, however, is under end-user demand to incorporate such capabilities as additional network switching, management control and diagnostics.

Rather than being a threat to modem producers, the T-1 is expected to benefit them somewhat. Paradyne doesn't believe that T-1 growth will cut modem sales. The company expects existing markets to expand as companies broaden their networks.

As for **the competition**, General DataComm was estimated (Electronic News-9/15/86) to hold a 20% share of the **installed** T-1 multiplexer market, with Timeplex second at 16% and AT & T third at 9%. Major players in this market include the above companies, plus.........Infotron Systems, Digital Communications Associates, Avanti Corp., Network Equipment Technologies, Paradyne, and Racal Electronics. There are reports that even IBM is interested in the field.

The leading competitors in the **overall** multiplexer market include the following.............General DataComm, Timeplex, AT & T, Emulex, Paradyne, Universal Data Systems (Motorola), Racal-Vadic and Racal-Milgo, and Digi-Voice Corp.

NEW TECHNOLOGIES & CURRENT MARKET DEVELOPMENTS

DATA-OVER-VOICE MULTIPLEXING

A multiplexing technology known as "data-over-voice" (DOV) in the customer-premises equipment world and "data-over-voice multiplexing" (DVM) to telecommunications companies is said to provide a reliable, easily implemented medium-speed (19.2 kbps) link between telephone subscribers and central office services, including packet networks and company-based LANs, at a remarkably low cost.

DOV multiplexers use a form of frequency-division multiplexing (FDM) to overlay data on single two-wire twisted pairs (ordinary telephone wire) so that the cable carries both full-duplex data and voice traffic simultaneously.

Customer-premises data-over-voice equipment has found a ready market as an alternative to RS-232 cable installations, due to significant cost savings. In offices where workers are moved frequently, the mobility of plug-in terminal installations becomes important. It has been estimated that the average terminal is moved at least once per year, and the cost of a hard-wired terminal can be as high as $1500, with $400 per move common. Also, because data shares the line with voice, the phone is **always** available, an improvement over modems which can tie up phone lines for hours. When a company moves, the cabling investment is usually entirely lost. Approximately 100,000 channels of data-over-voice products are currently installed in the U.S.

Although originally marketed as a solution to this in-house cabling problem, many telephone companies are considering incorporating DVMs into their packet networks as an antibypass strategy. The data-over-voice link makes an attrative Centrex enhancement. Also, as a component in a networking scheme to be offered as an ISDN alternative, data-over-voice has the advantage of being available **now**.

INDEPENDENT DATA COMMUNICATIONS MANUFACTURERS ASSOCIATION URGES FCC TO RETAIN CPE CLASSIFICATION OF MULTIPLEXERS

The FCC should maintain its classification of multiplexers installed at customer locations as customer-premises equipment (CPE) and resist pressures to reclassify them as part of the telephone network, the IDCMA said in August 1987. Pacific Telesis and Verilink Corp. have been pressing the FCC to change the classification of multiplexers, which must be offered on an unbundled basis by Bell Operating Companies.

The FCC's Common Carrier Bureau approved further testing and ruled that the multiplexers should not be bundled with the service but, instead, should be availalbe to customers from other vendors. That decision was welcomed by IBM, the IDCMA and other equipment suppliers. Independent equipment manufacturers want to protect their right to provide products as part of future service offerings from the BOCs.

The IDCMA stated that........" if the commission were to make the mistake of expanding the limited exception by allowing carriers to absorb such multiplexers into the regulated network, users would lose the many benefits of having such devices offered in the competitive market, where price considerations and the availablity of innovative technical features guide consumers' choices."

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

DIGITAL MULTIPLEXER SALES (Dollars & Units)

	SALES ($ Thous.)	ANNUAL % CHG.	UNIT SHIPMENTS	ANNUAL % CHG.	NO. OF PRODUCING COMPANIES
1977	$155,251		22,961		11
1978	104,582	-32.6	42,041	83.1	18
1979	191,014	82.6	69,871	66.2	24
1980	242,989	27.2	124,953	78.8	21
1981	349,159	43.7	179,475	43.6	23
1982	391,212	12	197,221	9.9	23
1983	437,497	11.8	269,450	36.6	22
1984	491,823	12.4	315,261	17	25
1985	496,420	0.9	268,369	-14.9	21
ESTIMATE **1987**	**607.0**	**11.1***	**305,950**	**7.0***	—
FORECAST **1992**	**1,062.0**	**15.0***	**413,000**	**7.0***	—

* Average annual rate of growth

SOURCE: U.S DEPT. OF COMMERCE, CURRENT INDUSTRIAL REPORTS

EXPORT OPPORTUNITIES & IMPORT COMPETITION

Exports data for modems and multiplexers devices **alone** are not available from the usual official sources such as the Commerce Department. However, there **is** a category of products termed "digital and analog communications carrier equipment", which **does** include modems and multiplexers, along with many other devices (controllers, keyboards, magnetic tape evaluators, other computer peripheral devices). In this section is a 1979-1986 analysis of U.S. producers' exports of all this equipment.

Such exports have risen in value at a 25.7% average annual pace since 1979, from $296 million to an estimated $829 million. Volume was up a marginal 0.2% in 1986.

Also, Electronics, in its January 1987 "Overseas Market Report", listed the 1985-87 values of several European and Japanese markets for **total data communications equipment.** Together, Japan, West Germany, England, France and Italy will constitute an estimated $1.057 billion market this year, up from $968 million in 1986. Japan is the largest market, with $491 million worth of such gear sold yearly. The **fastest-growing** market over the period 1985-87 appears to be the United Kingdom, averaging 23.9% growth. Japan's data communications market is growing 14.3% per year.

U.S. modem and multiplexer manufacturers should consider these markets first, as possible export opportunities. The weaker dollar, coupled with Japan's recent relaxation of import duties and restrictions on U.S. products, should make it easier to sell abroad. But, of course, devices must conform to local industry standards to compete effectively.

IMPORTS in the modem and multiplexer market do not appear to be as significant a factor as in other electronics markets. The exact dollar volume is not known, but probably is realistically in the range of $100-200 million annually. The main Japanese players in the market include NEC America (San Jose, CA) and Fujitsu America (also San Jose).

NEC sells the TC-500A statistical multiplexer, the DSP9630 two-wire, V.32 full duplex dial-up modem (to 9600 bps, CCITT), and the DSP19200MII, Trellis coded 19,200 bps, four-wire leased-line ultra high-speed modem. NEC also produces a Network Control and Management System. **Fujitsu** is selling a new two-channel stand-alone modem, a 19.2 Kbps, Trellis-coded model.

THE ELECTRONIC MODEMS & MULTIPLEXERS MARKET

EXPORTS OF DIGITAL & ANALOG COMMUNICATIONS CARRIER EQUIPMENT, MULTIPLEXORS, ETC. *

	VALUE OF EXPORTS (Producer's Value, Excl. freight-$ Mill.)	ANNUAL PERCENT CHANGE
1979	$296.0	
1980	359.8	21.6
1981	429.2	19.3
1982	504.6	17.6
1983	533.5	5.7
1984	749.6	40.5
1985	827.9	10.5
1986 Est.	829.7	0.2

*** Exports of modems and multiplexors not available separately--combined with: magnetic tape cleaners, disk pack inspectors, magnetic tape evaluators, decoders, digital cassette recorders, upgraders, controllers, electronic keyboards, disc & tape controllers, other peripheral equipment.**

SOURCE: U.S. DEPT. OF COMMERCE, MARKETDATA PERCENT CHANGE CALCULATIONS

THE ELECTRONIC MODEMS & MULTIPLEXORS MARKET

MAJOR OVERSEAS MARKETS FOR DATA COMMUNICATIONS EQUIPMENT

1985-1987 PROJECTED GROWTH
(SALES - $ MILLIONS)

	1985	1986	1987	AVERAGE GROWTH PER YEAR 1985-87 (Percent)
JAPAN	$382.0	$451.0	$491.0	14.3
WEST GERMANY	145	150	158	4.5
UNITED KINGDOM	94	114	139	23.9
FRANCE	185	194	204	5.1
ITALY	54	59	65	10.2
5-COUNTRY TOTAL:	860	968	1,057	11.5

SOURCE: ELECTRONICS OVERSEAS MARKET REPORT (1/22/1987),
MARKETDATA GROWTH CALCULATIONS

COMPUTER-SEARCHED ABSTRACTS OF MODEM & MULTIPLEXER SALES FORECASTS

One of the best methods of collecting a wide variety of **current** information about a particular market, topic or industry is to utilize a computerized business database that is continuously updated. Marketdata, in order to provide a view of how ***other*** industry analysts, market research firms, and trade journals see the market for modems and multiplexers, has performed a custom database search.

A particularly good database to use is the **Predicast U.S. Forecasts** file, under the scope of **Dialog Information Services**. Marketdata has searched this database for **SIC code 36612,** from January 1986 to August 1987, for published articles containing forecasts about the size and nature of the market. Each of the 125+ abstracts contained in this section contains bibliographic information regarding the source, date of publication, page number, etc.--so that the reader may refer to the **entire** article for more information, if desired.

Abstracts cover estimates and forecasts spanning the period 1982-1991, and cover the following topics: sales and unit production of modems by end-user, percent of market, consumption of integrated circuits, modem sales by speed (600, 1200, 2400, 4800, 9600, 14,400 bps), by type: stand-alone, board level, integral, voice grade, radio frequency, short haul, full and half-duplex.

Abstracts in this section were published by the following trade journals:

Appliance
Computer Communications
Communications International
Data Processing
Electronics
Electronic Business
Electronics Marketing
Electronics Week
High Technology
Industry Week
IRD News
Mini Micro
Office Systems

The following market research firms were cited as the source of these abstracts...........

Creative Alternatives
Creative Strategies Intl.
Dataquest
Future Computing
Frost & Sullivan
Gnostic Concepts
International Data Corp.
International Planning Info.
Technology Financial Services
Venture Development

The information in these abstracts allow Marketdata to view the full range of market forecasts made, formulating its own "consensus" forecast of the market, corroborating trends uncovered by other research, directions in various market segments, leading to what we feel is the most accurate forecast possible.

Companies may access these business databases themselves with a computer terminal and modem, at any time, obtaining abstracts on-line at their printer, at roughly $.25-.30 per abstract. But, you need the proper guide, passwords, and general knowledge of the database you are searching, in order to minimize wasted time connected to the service. Many times, it is easier to use a local university business library's staff to do the search for you. Know beforehand the specific information you need, the SIC code of the market you need information about, the time period--be as specific as possible. A few abstracts can be printed for you on-line as you wait, to give you a sample of the type information you will receive. Then, the rest can be printed off-line, usually within a week, at about $.50 each.

Consequently, a typical search, including the staff person's time, will cost $75-100, an inexpensive method to gather market information quickly, from a comprehensive array of sources. It is recommended highly by Marketdata as part of any company's total planning, forecasting, and market research process. Of course, hundreds of other databases exist--for example, the National Technical Information Service (NTIS) for technical/engineering abstracts, DISCLOSURE--for company annual report information, etc.

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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1193119   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. stsndard integrated circuits.

            YEAR     mil  $

            1985        62.2
            1990        71.6

  GROWTH RATE= 2.9%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465

1193118   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. integrated circuits.

            YEAR     mil  $

            1985        92.9
            1990       143.2

  GROWTH RATE= 9.0%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465

1193117   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. logic circuits.

            YEAR     mil  $

            1985         12.
            1990        18.6

  GROWTH RATE= 9.2%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465

1193116   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. memory circuits.

            YEAR     mil  $

            1985        15.8
            1990        18.6

  GROWTH RATE= 3.3%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465

1193115   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. linear integrated circuits.

            YEAR     mil  $
```

```
            1985        20.5
            1990         33.

  GROWTH RATE= 10.0%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465

1193114   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. MPU.

            YEAR     mil  $

            1985        44.6
            1990         73.

  GROWTH RATE= 10.4%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465

1178614   Electronic  87/01/08  P84   United States
  Modems, 301 1200 bps. production. (300 1,200 bps).

            YEAR     000  units

            1986       504.4Q
            1991       485.1Q

  GROWTH RATE= -0.8%
  Venture Development
  CC=1USA   PC=3661274   EC=622

1178613   Electronic  87/01/08  P84   United States
  Modems, 4801 9600 bps. production. (9,600 bps).

            YEAR     000  units

            1986         4.7Q
            1991       275.1Q

  GROWTH RATE= 125.7%
  Venture Development
  CC=1USA   PC=3661278   EC=622

1178612   Electronic  87/01/08  P84   United States
  Modems, 2401 4800 bps. production. (4,800 bps).

            YEAR     000  units

            1986        16.4Q
            1991      1262.1Q
```

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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

```
  GROWTH RATE= 138.4%
  Venture Development
  CC=1USA    PC=3661276    EC=622

1178611   Electronic  87/01/08  P84   United States
  Modems, 1201 2400 bps. production. (2,400 bps).

             YEAR      000  units

             1986       256.5Q
             1991      1262.1Q

  GROWTH RATE= 37.5%
  Venture Development
  CC=1USA    PC=3661275    EC=622

1178610   Electronic  87/01/08  P84   United States
  Data Modems. production. .

             YEAR      000  units

             1986         782.
             1991        2100.

  GROWTH RATE= 21.8%
  Venture Development
  CC=1USA    PC=3661271    EC=622

1177264   Electronic  87/01/08  P59   United States
  Data Modems. sales. (radio frequency).

             YEAR      MIL  $

             1985          27.
             1986          33.
             1987          41.


  GROWTH RATE= 23.2%
  CC=1USA    PC=3661271    EC=652

1177263   Electronic  87/01/08  P59   United States
  Data Modems. sales. (low speed under 2,400 bps).

             YEAR      MIL  $

             1985         327.
             1986         402.
             1987         422.


  GROWTH RATE= 13.6%
  CC=1USA    PC=3661271    EC=652
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1177262   Electronic  87/01/08  P59   United States
  Data Modems. sales. (high speed 2,400 bps & over).

             YEAR      MIL  $

             1985        1297.
             1986        1520.
             1987        1660.


  GROWTH RATE= 13.1%
  CC=1USA    PC=3661271    EC=652

1177261   Electronic  87/01/08  P59   United States
  Data Modems. sales. .

             YEAR      MIL  $

             1985        1651.
             1986        1955.
             1987        2123.


  GROWTH RATE= 13.4%
  CC=1USA    PC=3661271    EC=652

1173179   Data Proc  86/08/00  P329   United States
  Communication Software Pkgs. sales. (data comm,for
microcomp/modems).

             YEAR           % of market

             1990          50.
             1990

  Frost & Sullivan
  CC=1USA    PC=7372600    EC=652

1172785   Office Sys  86/11/00  P24   United States
  Data Modems. shipments. (voice grade).

             YEAR      000  units

             1985         974.
             1990        3400.

  GROWTH RATE= 28.4%
  Venture Development
  CC=1USA    PC=3661271    EC=631
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```
DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1169433   Comp Comm  86/08/00  P204     United States
  Micro/modem software. sales. .

          YEAR      MIL  $

          1985       115.80
          1990         695.

  GROWTH RATE= 43.1%
  Frost & Sullivan
  CC=1USA   PC=7372490   EC=652


1167094   Info Pt 1  86/09/00  P18     United States
  Micro/modem data comm software. sales. .

          YEAR      MIL  $

          1990      1400.0


  Frost & Sullivan
  CC=1USA   PC=7372699   EC=652


1166430   Ind Week  86/C9/01  PBC24     United States
  Data modems. sales. .

          YEAR      BIL  $

          1985         1.3
          1990         2.

  GROWTH RATE= 9.0%
  Intnl Data
  CC=1USA   PC=3661271   EC=652


1166330   High Tech  86/09/00  P72     United States
  T1 multiplexors. sales. .

          YEAR      MIL  $

          1985         125.
          1987         240.
          1990         505.


  GROWTH RATE= 32.2%
  Technology Financial Services
  CC=1USA   PC=3661263   EC=652


1163632   Appliance  86/09/00  P72     United States
  Data modems. avg life. (first owner usage basis).

          YEAR            years
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```
          1987          5.


  CC=1USA   PC=3661271   EC=345


1163526   Appliance  86/09/00  P72     United States
  Data modems. sales for. replacement.

          YEAR      000  units

          1986        112.
          1987        200.

  GROWTH RATE= 78.6%
  CC=1USA   PC=3661271   EC=664


1157502   Elec Mkt  86/00/00  P57     United States
  Modems,2401 4800 bps. shipments. .

          YEAR      MIL  units

          1987          1.


  CC=1USA   PC=3661276   EC=631


1157501   Elec Mkt  86/00/00  P57     United States
  Modems,under 2400 bps. shipments. .

          YEAR      MIL  units

          1987          2.


  CC=1USA   PC=3661275   EC=631


1157500   Elec Mkt  86/00/00  P57     United States
  Modems,2401 4800 bps. shipments. as % of all modems shipped.

          YEAR           % of total

          1987         43.


  CC=1USA   PC=3661276   EC=631
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1157499   Elec Mkt  86/00/00  P57      United States
  Modems,over 4800 bps. shipments. .

           YEAR     000  units

           1987       250.-


  CC=1USA   PC=3661278   EC=631

1157498   Elec Mkt  86/00/00  P57      United States
  Data modems. sales for. personal computers.

           YEAR     MIL  $

           1985        760.
           1986       1000.
           1990       2400.

  GROWTH RATE= 25.9%
  Future Computing
  CC=1USA   PC=3661271,3573098   EC=664

1157497   Elec Mkt  86/00/00  P57      United States
  Data modems. sales. .

           YEAR     BIL  $

           1985          1.1
           1987          1.7

  GROWTH RATE= 24.3%
  Venture Development
  CC=1USA   PC=3661271   EC=652

1157496   Elec Mkt  86/00/00  P57      United States
  Data modems. sales. .

           YEAR     BIL  $

           1984          1.8
           1990          2.7

  GROWTH RATE= 7.0%
  Frost & Sullivan
  CC=1USA   PC=3661271   EC=652

1155584   Data Proc  86/04/00  P161      United States
  Data modems. sales to. insurance companies.

           YEAR     000  units
```

```
           1984            -
           TO        171.3
           1989            -


  Frost & Sullivan
  CC=1USA   PC=3661271,6300000   EC=664

1155583   Data Proc  86/04/00  P161      United States
  Insurance companies. purchase of. data modems.

           YEAR     000  units

           1984            -
           TO        171.3
           1989            -


  Frost & Sullivan
  CC=1USA   PC=6300000,3661271   EC=437

1142989   IRD News  86/04/28  P5      United States
  Data modems. sales. (3270 terminals related).

           YEAR     MIL  $

           1986      625.30


  CC=1USA   PC=3661271   EC=652

1142584   Data Proc  85/12/00  P40      United States
  Data modems. sales. .

           YEAR     BIL  84$

           1989        2.30


  Frost & Sullivan
  CC=1USA   PC=3661271   EC=652

1126477   Electronic  86/01/06  P46      United States
  Radio frequency modems. sales. .

           YEAR     MIL  $

           1984         20.
           1985         27.
           1986         33.
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

  GROWTH RATE= 22.2%*
  CC=1USA    PC=3661279    EC=652

1126476    Electronic   86/01/06   P46      United States
  Modems,under 2400 bps. sales. .

             YEAR      MIL  $

             1984         281.
             1985         327.
             1986         406.

  GROWTH RATE= 24.2%*
  CC=1USA    PC=3661275    EC=652

1126475    Electronic   86/01/06   P46      United States
  Modems,2400 bps & over. sales. .

             YEAR      MIL  $

             1984        1135.
             1985        1297.
             1986        1535.

  GROWTH RATE= 18.4%*
  CC=1USA    PC=3661276    EC=652

1126474    Electronic   86/01/06   P46      United States
  Data modems. sales. .

             YEAR      MIL  $

             1984        1436.
             1985        1651.
             1986        1974.

  GROWTH RATE= 19.6%*
  CC=1USA    PC=3661271    EC=652

1123458    Comp Comm   85/08/00   P203      United States
  IBM PC & compatible modems. shipments. .

             YEAR      MIL  $

             1984         246.
             1988         615.

  GROWTH RATE= 25.7%
  Frost & Sullivan
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  CC=1USA    PC=3661271    EC=631
1123457    Comp Comm   85/08/00   P203      United States
  IBM PC & compatible modems. shipments. .

             YEAR      000  units

             1984         542.
             1988        1300.

  GROWTH RATE= 24.4%
  Frost & Sullivan
  CC=1USA    PC=3661271    EC=631

1122241    Mini Micro   85/11/00   P46      United States
  PC data modems. sales. .

             YEAR      MIL  $

             1985         760.
             1986        1000.
             1990        2400.

  GROWTH RATE= 25.9%
  Future Computing
  CC=1USA    PC=3661271    EC=652

1121125    Frost 1528   85/10/00   P2      United States
  PC data modems. shipments. .

             YEAR      BIL  $

             1984          1.3
             1989         2.30

  GROWTH RATE= 12.1%
  CC=1USA    PC=3661271    EC=631

1118162    Electronic   85/09/09   P20      United States
  Data modems. sales. .

             YEAR      BIL  $

             1985          1.1
             1987          1.7

  GROWTH RATE= 24.3%
  Garrett, WC  analyst,Venture Development
  CC=1USA    PC=3661271    EC=652
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1118161   Electronic  85/09/09  P20     United States
  High speed modems. sales. (over 4,800 bps).

          YEAR      MIL  $

          1985         346.
          1987         497.

  GROWTH RATE= 19.9%
  Garrett, WC  analyst,Venture Development
  CC=1USA    PC=3661278    EC=652

1118075   Ec World  85/10/00  P24     United States
  Data modems. sales for. home computer use.

          YEAR          index

          1984          100.
          1987         134.1

  GROWTH RATE= 10.3%
  Frost & Sullivan
  CC=1USA    PC=3661271    EC=654

1117628   Frost 1210  85/10/00  P2     United States
  Data modems. sales to. insurance companies.

          YEAR      MIL  $

          1984              -
          TO        171.3
          1989              -

  CC=1USA    PC=3661271,6300000    EC=664

1117627   Frost 1210  85/10/00  P2     United States
  Insurance companies. expend for. data modems.

          YEAR      MIL  $

          1984              -
          TO        171.3
          1989              -

  CC=1USA    PC=6300000,3661271    EC=437

1117626   Frost 1210  85/10/00  P2     United States
  Data modems. sales to. insurance companies.

          YEAR      000  units

          1984              -
          TO        171.3
          1989              -

  CC=1USA    PC=3661271,6300000    EC=664

1117625   Frost 1210  85/10/00  P2     United States
  Insurance companies. purchase of. data modems.

          YEAR      000  units

          1984              -
          TO        171.3
          1989              -

  CC=1USA    PC=6300000,3661271    EC=437

1116996   Cdn Data  85/09/00  P90     United States
  Datacomm network access eqp. sales. (mainly dial back
modems).

          YEAR      MIL  85$

          1985          40.
          1990          90.

  GROWTH RATE= 17.6%
  Intnl Planning Information
  CC=1USA    PC=3662364    EC=652

1116849   Comm Intnl  85/09/00  P14     United States
  Data modems. in use by. personal computers.

          YEAR      BIL  $

          1989           2.


  Frost & Sullivan
  CC=1USA    PC=3661271,3573098    EC=665

1116848   Comm Intnl  85/09/00  P14     United States
  Data modems. in use by. personal computers.

          YEAR          % of prodB

          1989          60.
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

  Frost & Sullivan
  CC=1USA   PC=3661271,3573098   EC=665

1116847   Comm Intnl  85/09/00  P14     United States
  Personal computers. use of. data modems.

           YEAR          % of prodA

           1989          60.

  Frost & Sullivan
  CC=1USA   PC=3573098,3661271   EC=442

1116846   Comm Intnl  85/09/00  P14     United States
  Data modems. in use by. personal computers.

           YEAR     MIL  units

           1989          2.

  Frost & Sullivan
  CC=1USA   PC=3661271,3573098   EC=665

1116845   Comm Intnl  85/09/00  P14     United States
  Personal computers. use of. data modems.

           YEAR     MIL  units

           1989          2.

  Frost & Sullivan
  CC=1USA   PC=3573098,3661271   EC=442

1113326   Appliance  85/09/00  P57     United States
  Data modems. avg life. (first owner usage basis).

           YEAR          years

           1986          5.

  CC=1USA   PC=3661271   EC=345

1112265   Appliance  85/09/00  P57     United States
  Data modems. sales for. replacement.

           YEAR     000  units

           1985       40.2
           1986      112.3

  GROWTH RATE= 179.4%
  CC=1USA   PC=3661271   EC=664

1111217   Frost 1491  85/08/00  P2     United States
  Personal computers. use of. data modems.

           YEAR          % of prodA

           1989          60.

  CC=1USA   PC=3573098,3661271   EC=442

1111216   Frost 1491  85/08/00  P2     United States
  Personal computers. use of. data modems.

           YEAR     MIL  units

           1989          2.

  CC=1USA   PC=3573098,3661271   EC=442

1111211   Frost 1491  85/08/00  P1     United States
  Data modems. sales. .

           YEAR     MIL  units

           1984        1.5
           1990       17.9

  GROWTH RATE= 51.2%
  CC=1USA   PC=3661271   EC=652

1111210   Frost 1491  85/08/00  P1     United States
  Data modems. sales. .

           YEAR     MIL  84$

           1984      1180.
           1990      2730.

  GROWTH RATE= 15.0%
  CC=1USA   PC=3661271   EC=652
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1109176   Elec Mkt  85/00/00  P54      United States
  Data modems,under 2400 bps. sales. .

             YEAR     MIL  units

             1987           2.


  CC=1USA    PC=3661275    EC=652


1109175   Elec Mkt  85/00/00  P54      United States
  Data modems,2401 4800 bps. sales. .

             YEAR     MIL  units

             1987           1.


  CC=1USA    PC=3661276    EC=652


1109174   Elec Mkt  85/00/00  P54      United States
  Data modems,2401 4800 bps. sales. as % of all modem sales.

             YEAR           % of total

             1987          43.


  CC=1USA    PC=3661276    EC=652


1109173   Elec Mkt  85/00/00  P54      United States
  Data modems. sales. .

             YEAR     BIL  $

             1983          .8
             1987          2.

  GROWTH RATE= 25.7%
  Venture Development
  CC=1USA    PC=3661271    EC=652

1109086   Frost 1279  85/07/00  P2      United States
  Data modems. sales for. home computers.

             YEAR           index

             1984        100.
             1987       134.10

  GROWTH RATE= 10.3%
  CC=1USA    PC=3661272,3573098    EC=664
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1108467   Elec Mkt  85/00/00  P79      United States
  Data modems. sales. .

             YEAR     000  units

             1983        866.
             1987       3500.

  GROWTH RATE= 41.8%
  Venture Development
  CC=1USA    PC=3661271    EC=652

1103180   Office Sys  85/05/00  P42      United States
  Data modems. sales. .

             YEAR     BIL  $

             1984          1.3
             1988          3.

  GROWTH RATE= 23.3%
  Turkot, TE  pres,Creative Alternatives
  CC=1USA    PC=3661271    EC=652

1096870   Elec Busns  85/04/01  P72      United States
  Microcomputer modems. shipments. (direct).

             YEAR           % of market

             1983          56.
             1988          51.

  GROWTH RATE= -1.9%
  Intnl Data
  CC=1USA    PC=3661271    EC=631

1096869   Elec Busns  85/04/01  P72      United States
  Microcomputer modems. shipments. (OEM).

             YEAR           % of market

             1983           4.
             1988          11.

  GROWTH RATE= 22.4%
  Intnl Data
  CC=1USA    PC=3661271    EC=631
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1096868   Elec Busns  85/04/01  P72     United States
  Microcomputer modems. shipments. (third party).

             YEAR           % of market

             1983         40.
             1988         38.

  GROWTH RATE= -1.0%
  Intnl Data
  CC=1USA    PC=3661271    EC=631

1096867   Elec Busns  85/04/01  P71     United States
  Microcomputer modems. shipments. (stand alone).

             YEAR     MIL  $

             1983      145.8Q
             1985       333.Q
             1988       675.Q


  GROWTH RATE= 35.9%
  Creative Strategies Intnl
  CC=1USA    PC=3661271    EC=631

1096866   Elec Busns  85/04/01  P71     United States
  Microcomputer modems. shipments. (integral).

             YEAR     MIL  $

             1983        4.9Q
             1985       55.5Q
             1988       375.Q


  GROWTH RATE= 138.1%
  Creative Strategies Intnl
  CC=1USA    PC=3661271    EC=631

1096865   Elec Busns  85/04/01  P71     United States
  Microcomputer modems. shipments. (board level).

             YEAR     MIL  $

             1983       11.3Q
             1985      166.5Q
             1988       450.Q


  GROWTH RATE= 108.9%
  Creative Strategies Intnl
  CC=1USA    PC=3661271    EC=631
```

```
1096864   #Elec Busns  85/04/01  P71     United States
  Microcomputer modems. shipments. by design type.

             YEAR     MIL  $

             1983        162.
             1985        555.
             1988       1500.


  GROWTH RATE= 56.1%
  Creative Strategies Intnl
  CC=1USA    PC=3661271    EC=631

1096863   Elec Busns  85/04/01  P70     United States
  Microcomputer modems,2400 bps. shipments. .

             YEAR     000  units

             1985        23.Q
             1988       830.Q

  GROWTH RATE= 230.5%
  Creative Strategies Intnl
  CC=1USA    PC=3661275    EC=631

1096862   Elec Busns  85/04/01  P70     United States
  Microcomputer modems,1200 bps. shipments. .

             YEAR     000  units

             1983      344.5Q
             1985      1863.Q
             1988      6972.Q


  GROWTH RATE= 82.5%
  Creative Strategies Intnl
  CC=1USA    PC=3661274    EC=631

1096861   Elec Busns  85/04/01  P70     United States
  Microcomputer modems,300 bps. shipments. .

             YEAR     000  units

             1983      185.5Q
             1985       414.Q
             1988       498.Q

  GROWTH RATE= 21.8%
  Creative Strategies Intnl
                                (cont. next page)
```

DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

```
  CC=1USA    PC=3661272    EC=631
1096860    #Elec Busns  85/04/01  P70      United States
  Microcomputer modems. shipments. by speed type.

          YEAR      000  units

          1983        530.
          1985       2300.
          1988       8300.


  GROWTH RATE= 73.4%
  Creative Strategies Intnl
  CC=1USA    PC=3661271    EC=631

1086996    Mini Micro  85/02/15  P17      United States
  Data modems,14,400 bps. shipments. .

          YEAR      MIL  $

          1982         22.
          1985         66.
          1988        127.6


  GROWTH RATE= 34.0%
  Intnl Data
  CC=1USA    PC=3661279    EC=631

1086995    Mini Micro  85/02/15  P17      United States
  Data modems,2400 bps. shipments. .

          YEAR      MIL  $

          1982        103.
          1985        155.4
          1988        193.2


  GROWTH RATE= 11.1%
  Intnl Data
  CC=1USA    PC=3661275    EC=631

1086994    Mini Micro  85/02/15  P17      United States
  Short haul data modems. shipments. .

          YEAR      MIL  $

          1982         52.8
          1985        154.
          1988        218.7


  GROWTH RATE= 26.7%
```

```
  Intnl Data
  CC=1USA    PC=3661272    EC=631

1086993    Mini Micro  85/02/15  P17      United States
  Data modems,4800 bps. shipments. .

          YEAR      MIL  $

          1982        203.2
          1985        317.3
          1988        397.7


  GROWTH RATE= 11.8%
  Intnl Data
  CC=1USA    PC=3661276    EC=631

1086992    Mini Micro  85/02/15  P17      United States
  Data modems,9600 bps. shipments. .

          YEAR      MIL  $

          1982        289.4
          1985        518.7
          1988        768.


  GROWTH RATE= 17.7%
  Intnl Data
  CC=1USA    PC=3661278    EC=631

1086991    Mini Micro  85/02/15  P14      United States
  Data modems,1200 bps. shipments. (half duplex).

          YEAR      MIL  $

          1982         39.5
          1985         42.9
          1988         42.8


  GROWTH RATE= 1.3%
  Intnl Data
  CC=1USA    PC=3661274    EC=631

1086990    Mini Micro  85/02/15  P14      United States
  Data modems,1200 bps. shipments. (full duplex).

          YEAR      MIL  $

          1982         97.2
```

(cont. next page)

```
          1985       234.6
          1988        334.


  GROWTH RATE= 22.8%
  Intnl Data
  CC=1USA   PC=3661274   EC=631


1086989   Mini Micro  85/02/15  P13     United States
  Data modems,0 600 bps. shipments. .

          YEAR     000  units

          1982       248.9
          1985       405.7
          1988        525.


  GROWTH RATE= 13.2%
  Intnl Data
  CC=1USA   PC=3661272   EC=631


1086988   Mini Micro  85/02/15  P13     United States
  Data modems,1200 bps. shipments. (half duplex).

          YEAR     000  units

          1982        98.7
          1985       126.3
          1988       152.8


  GROWTH RATE= 7.6%
  Intnl Data
  CC=1USA   PC=3661274   EC=631


1086987   Mini Micro  85/02/15  P13     United States
  Data modems,1200 bps. shipments. (full duplex).

          YEAR     000  units

          1982       194.5
          1985        483.
          1988        845.


  GROWTH RATE= 27.7%
  Intnl Data
  CC=1USA   PC=3661274   EC=631
```

```
1084552   ElectrncWk  85/01/01  P74     United States
  Stand alone modems. sales. .

          YEAR     MIL  $

          1983        788.
          1988       1592.


  GROWTH RATE= 15.1%
  Dataquest
  CC=1USA   PC=3661271   EC=652


1083039   Appliance  85/01/00  P43     United States
  Data modems. sales. .

          YEAR     000  units

          1983        117.
          1984        180.
          1985        250.


  GROWTH RATE= 38.9%*
  CC=1USA   PC=3661271   EC=652


1081771   #Mini Micro  85/01/00  P33     United States
  Data modems. shipments. by type.

          YEAR     MIL  $

          1983      1072.5
          1984      1304.3
          1988      2781.2


  GROWTH RATE= 20.8%*
  Intnl Data
  CC=1USA   PC=3661271   EC=631


1081770   #Mini Micro  85/01/00  P33     United States
  Data modems. shipments. by type.

          YEAR     000  units

          1983      1324.5
          1984      1669.5
          1988      3129.1


  GROWTH RATE= 17.0%*
  Intnl Data
  CC=1USA   PC=3661271   EC=631
```

DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

```
1081769   Mini Micro  85/01/00  P33     United States
  Short haul data modems. shipments. .

               YEAR     000  units

               1983        248.
               1984        340.
               1988        625.

  GROWTH RATE= 16.4%*
  Intnl Data
  CC=1USA   PC=3661272   EC=631

1081766   Mini Micro  85/01/00  P33     United States
  Data modems,14,400 bps. shipments. .

               YEAR     000  units

               1983         3.2
               1984         4.6
               1988        11.6

  GROWTH RATE= 26.0%*
  Intnl Data
  CC=1USA   PC=3661279   EC=631

1081765   Mini Micro  85/01/00  P33     United States
  Data modems,9600 bps. shipments. .

               YEAR     000  units

               1983         84.
               1984        107.5
               1988        243.8

  GROWTH RATE= 22.7%*
  Intnl Data
  CC=1USA   PC=3661278   EC=631

1081762   Mini Micro  85/01/00  P33     United States
  Data modems,4800 bps. shipments. .

               YEAR     000  units

               1983        129.5
               1984        161.9
               1988        305.9

  GROWTH RATE= 17.2%*
  Intnl Data
  CC=1USA   PC=3661276   EC=631
1081761   Mini Micro  85/01/00  P33     United States
  Data modems,2400 bps. shipments. .

               YEAR     000  units

               1983        184.
               1984        217.
               1988        420.

  GROWTH RATE= 17.9%*
  Intnl Data
  CC=1USA   PC=3661275   EC=631

1081755   Mini Micro  85/01/00  P33     United States
  Data modems,0 600 bps. shipments. .

               YEAR     MIL  $

               1983        53.9
               1984        57.6
               1988        58.8

  GROWTH RATE= 0.5%*
  Intnl Data
  CC=1USA   PC=3661272   EC=631
```

```
DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1194781   Elec Busns  87/04/01  P41   United States
  Data Communications Equip. sales. (modem based network mgmt
systems).

           YEAR      mil  $

           1986        104.5
           1990        137.4

  GROWTH RATE= 7.1%
  Dataquest
  CC=1USA   PC=3661250   EC=652

1193143   Elec Busns  87/03/15  P40   United States
  Integrated Circuits. used in. modem equipment (custom ICs).

           YEAR          % of ICs

           1985          12.
           1990          20.

  GROWTH RATE= 10.8%
  Gnostic Concepts
  CC=1USA   PC=3674110   EC=691

1193142   Elec Busns  87/03/15  P40   United States
  Integrated Circuits. used in. modem equipment (semicustom
ICs).

           YEAR          % of ICs

           1985          21.
           1990          30.

  GROWTH RATE= 7.4%
  Gnostic Concepts
  CC=1USA   PC=3674110   EC=691

1193141   Elec Busns  87/03/15  P40   United States
  Integrated Circuits. used in. modem equipment (standard
ICs).

           YEAR          % of ICs

           1985          67.
           1990          50.

  GROWTH RATE= -5.7%
  Gnostic Concepts
  CC=1USA   PC=3674110   EC=691

1193140   Elec Busns  87/03/15  P40   United States
  Bipolar Logic ICs, TTL. used in. modem equipment (all logic
ICs).

           YEAR          % of ICs

           1985          13.
           1990          13.

  GROWTH RATE= 0.0%
  Gnostic Concepts
  CC=1USA   PC=3674131   EC=691

1193139   Elec Busns  87/03/15  P40   United States
  IC Memory Chips. used in. modem equipment.

           YEAR          % of ICs

           1985          17.
           1990          13.

  GROWTH RATE= -5.2%
  Gnostic Concepts
  CC=1USA   PC=3674126   EC=691

1193138   Elec Busns  87/03/15  P40   United States
  Linear Integrated Circuits. used in. modem equipment.

           YEAR          % of ICs

           1985          22.
           1990          23.

  GROWTH RATE= 0.9%
  Gnostic Concepts
  CC=1USA   PC=3674150   EC=691

1193137   Elec Busns  87/03/15  P40   United States
  Microprocessor Chips. used in. modem equipment.

           YEAR          % of ICs

           1985          48.
           1990          51.

  GROWTH RATE= 1.2%
  Gnostic Concepts
  CC=1USA   PC=3674124   EC=691
```

```
DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

1193136   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. custom integrated circuits.

          YEAR            % of ICs

          1985          12.
          1990          20.

 GROWTH RATE= 10.8%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193135   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. semicustom integrated circuits.

          YEAR            % of ICs

          1985          21.
          1990          30.

 GROWTH RATE= 7.4%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193134   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. standard integrated circuits.

          YEAR            % of ICs

          1985          67.
          1990          50.

 GROWTH RATE= -5.7%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193133   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. logic circuits.

          YEAR            % of ICs

          1985          13.
          1990          13.

 GROWTH RATE= 0.0%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193132   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. memory circuits.

          YEAR            % of ICs

          1985          17.
          1990          13.

 GROWTH RATE= -5.2%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193131   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. linear integrated circuits.

          YEAR            % of ICs

          1985          22.
          1990          23.

 GROWTH RATE= 0.9%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193130   Elec Busns  87/03/15  P40   United States
 Data Modems. consump of. MPU.

          YEAR            % of ICs

          1985          48.
          1990          51.

 GROWTH RATE= 1.2%
 Gnostic Concepts
 CC=1USA    PC=3661271    EC=465

1193129   Elec Busns  87/03/15  P40   United States
 Integrated Circuits. used in. modem equipment (custom ICs).

          YEAR     mil  $

          1985        11.2
          1990        28.6

 GROWTH RATE= 20.6%
 Gnostic Concepts
 CC=1USA    PC=3674110    EC=691

1193128   Elec Busns  87/03/15  P40   United States
 Integrated Circuits. used in. modem equipment (semicustom
ICs).

          YEAR     mil  $

          1985        19.5
          1990        43.
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DIALOG File 81: PTS US Forecasts - 71-87/July (Copr. Predicasts Inc. 1987)

  GROWTH RATE= 17.1%
  Gnostic Concepts
  CC=1USA   PC=3674110   EC=691


1193127   Elec Busns  87/03/15  P40   United States
  Integrated Circuits. used in. modem equipment (standard
ICs).

           YEAR      mil  $

           1985         62.2
           1990         71.6

  GROWTH RATE= 2.9%
  Gnostic Concepts
  CC=1USA   PC=3674110   EC=691


1193126   Elec Busns  87/03/15  P40   United States
  Integrated Circuits. used in. modem equipment.

           YEAR      mil  $

           1985          92.9
           1990         143.2

  GROWTH RATE= 9.0%
  Gnostic Concepts
  CC=1USA   PC=3674110   EC=691


1193125   Elec Busns  87/03/15  P40   United States
  Bipolar Logic ICs, TTL. used in. modem equipment (all logic
ICs).

           YEAR      mil  $

           1985          12.
           1990          18.6

  GROWTH RATE= 9.2%
  Gnostic Concepts
  CC=1USA   PC=3674131   EC=691


1193124   Elec Busns  87/03/15  P40   United States
  IC Memory Chips. used in. modem equipment.

           YEAR      mil  $

           1985          15.8
           1990          18.6

  GROWTH RATE= 3.3%
  Gnostic Concepts
  CC=1USA   PC=3674126   EC=691
1193123   Elec Busns  87/03/15  P40   United States
  Linear Integrated Circuits. used in. modem equipment.

           YEAR      mil  $

           1985          20.5
           1990          33.

  GROWTH RATE= 10.0%
  Gnostic Concepts
  CC=1USA   PC=3674150   EC=691


1193122   Elec Busns  87/03/15  P40   United States
  Microprocessor Chips. used in. modem equipment.

           YEAR      mil  $

           1985          44.6
           1990          73.

  GROWTH RATE= 10.4%
  Gnostic Concepts
  CC=1USA   PC=3674124   EC=691


1193121   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. custom integrated circuits.

           YEAR      mil  $

           1985          11.2
           1990          28.6

  GROWTH RATE= 20.6%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465


1193120   Elec Busns  87/03/15  P40   United States
  Data Modems. consump of. semicustom integrated circuits.

           YEAR      mil  $

           1985          19.5
           1990          43.

  GROWTH RATE= 17.1%
  Gnostic Concepts
  CC=1USA   PC=3661271   EC=465
```

MAJOR END-USER MARKETS FOR DATA COMMUNICATIONS EQUIPMENT - NATURE AND PERFORMANCE

DATA PROCESSING EQUIPMENT - COMPUTER MARKETS

Basically, the EDP market could be broken down into five sub-segments: the all-important Personal Computer market, Minicomputers, Mainframes, Supercomputers, and Technical Work Stations. Modem and multiplexor makers will, no doubt, be primarily concerned with the personal computer market, since the number of systems installed and yet to be sold, for personal and business use, far outnumbers the other segments. Consequently, the major part of this section is devoted to trends and developments in the PC market and its major producers.

Overview & Summary

A major source of information regarding the data processing equipment market comes from Electronics' annual "U.S. Market Report", last issued in January, 1987. A table of projected sales for each of the major computer sectors, from 1985-87, follows later on in this section.

Electronics expects total computer systems sales to rise 11.5%, to $49.78 billion in 1987, with mainframes accounting for over 33% of the total ($16.65 billion), followed by personal computer sales at 26.7% ($13.28 billion). The clear winner in terms of fastest growth will be **supercomputers**--up over 60% to $936 million in 1987. This is a category characterized by many powerful new products.

The reason that supercomputers are taking off so fast is due to big demand for very high-performance computing, helped by the steadily increasing price/performance ratio of this equipment. The newest and largest systems, such as the E-Series ETA by ETA Systems and Cray Research's Cray 2, cut the cost of supercomputing substantially. Minisupercomputers are smaller, more cost-effective versions of the giant supercomputers, and fill a performance gap between the most powerful superminis and the mainframes, while offering more attractive prices, sizes, and power requirements than the bigger machines.

The mainframe market, filled mainly by older, mature products, is expected to plod along at less than 5% growth. In the middle range, the hot

Continued................

area is minisupercomputers, which offer high performance at attractive prices. This new segment will account for sales of $307 million, an increase of nearly 54% in 1987.

The personal computer market is expected to advance by 14%, to $13.28 billion during 1987. Some of the new high-end PCs, those using the Intel 80386 processor, combined with new and inexpensive but high performance graphics subsystems, will fuel above-average growth of the market. Work stations should be another hot area, with sales expected to gain 35% in 1987, to $$2.2 billion.

Compaq Compuier of Houston is expecting 10-15% growth for this year. Revenues and profits are growing less than unit sales, as prices for many models drop continually, spurred by pressures from the array of IBM PC clone producers.

Another midrange machine expected to outperform the average growth rate is the **parallel computer,** which offers a broad range of performance levels. At least one expert in the field forecasts 25-30% growth in 1987. For the short term, market size will be small. It will most likely be at least three years before significant volumes are seen.

Traditional minicomputers and supermini sales will lag the market in general. Minicomputer sales are forecast to grow by only 3% to $2.3 billion in 1987, with superminis doing better at 13% growth to $9.6 billion.

As for technical work stations, high-end products will be the winners, especially those based on the Intel 80386 processor. Major players in this market include: Dana Computer, Prime Computer, Silicon Graphics, and Stellar Computer.

Following are some interesting statistics regarding computers in general, PCs, the installed base, and unit sales by manufacturer, from a variety of sources (The Yankee Group, Personal Computing magazine, International Data Corp.)..........

THE 10 COMPANIES WITH THE MOST PERSONAL COMPUTERS
(As of October 1986)

1) IBM
2) General Motors
3) Texas Instruments

Continued..............

Continued.........

4) General Electric
5) Traveler's Insurance
6) Westinghouse
7) Boeing
8) Ford Motor Co.
9) United Technologies
10) DuPont

TOP 10 PERSONAL COMPUTERS SINCE PRODUCT INTRODUCTION

(As of 1986)

1) IBM PC family	3,327,000	units sold
PC	2,164,000	
XT	881,000	
AT	282,000	
2) Commodore 64	2,750,000	
3) Apple II Series	2,172,000	
II Plus & IIe	1,677,000	
IIc	495,000	
4) Commodore Vic 20	1,310,000	
5) TRS-80 Color Computer	1,170,000	
6) Tandy Models 1-4	750,000	
7) Apple Macintosh	445,000	
8) IBM PCjr	350,000	
9) AT & T 6300	215,000	
10) Compaq Portable	213,000	

THE 10 LARGEST COMPUTER HARDWARE MANUFACTURERS

(Based on 1985 Unit Shipments)

1. IBM	1,464,860
2. Apple	987,000
3. Commodore	860,000]
4. Tandy	441,000
5. Atari	330,000
6. Compaq	216,000
7. AT & T	188,000
8. Hewlett-Packard	143,300
9. Zenith	102,600
10. Wang	75,000

A recent Wall Street Journal (8/20/87) article covered the topic of computer "add-ons" or peripheral products bought to enhance the value of the system to the user. Many computer owners may add equipment rather than scrap machines they bought just two or three years ago. This "aftermarket" consists of such equipment as **modems**, extra software, hard disks, memory boards, scanners, etc. The article quoted a PC Magazine survey that reported the percentage of corporate buyers planning to purchase these add-on devices for computers this year. **The most popular device was modems--52% planned to buy them**.

THE PERSONAL COMPUTER MARKET

After two years of sluggish growth, th PC market has rebounded strongly during 1987, paced by new products by IBM, Apple and Compaq, lower prices and enhanced capabilities. IBM set first-quarter PC sales records, with analysts estimating that it sold 80% more PC-ATs than a year ago. Tandy posted a 62% gain in unit sales of its IBM-compatible machines. Compaq Computer reported first-quarter sales up 39%. Apple Macintosh sales were up at least 30% in the March quarter.

This is in sharp contrast to 1985 and most of 1986. In little more than a decade, the PC market has grown into a $46 billion industry (incl. software and accessories). After annual growth of 60% or more, sales advanced less than 15% in 1985 and improved slightly to 18% in 1986. This decline coincided with the drastic slump in mainframe markets. Slower PC growth also triggered a shakeout among personal computer dealers, whose ranks were pared by more than one-third. This was coupled with falling prices, where IBM PC clones appeared on the market at one-third IBM's price by year-end 1986. These clones took 75% of the market that IBM virtually had to itself in 1984.

Apple introduced the Macintosh SE and Macintosh II, further spurring the market. These new units broke with the company's earlier philosophy of "closed architecture", allowing for expansion and modification, unlike earlier Macintosh models.

Much of the sales gains of IBM, Tandy and Compaq came at the expense of other companies such as AT & T, Tandon Corp., and Hewlett-Packard, as well as other lesser-known firms. It is estimated that during the first three months of 1987 IBM, Apple, Tandy and Compaq accounted for 75% of all computers sold.

What about computers and **small** business ? The fact is, more than 50% of all small businesses (5-99 employees) rely on personal computers. PCs are even more prevalent now than electronic typewriters. Personal Computing magazine's September 1987 issue contained a "data bank" of purchase plans by small business. The findings were as follows.............

* 16% of small businesses planned to buy personal computers in the next 12 months.
* 49-68% of small businesses are now using PCs (49% for the smallest firms: 5-9 employees, 68% for 50-99 employees)

Following is a company-by-company profile of the major players in the personal computer market, their recent new product introductions, market strategies, performance, etc.

IBM

The latest development for IBM, of course, was the introduction of its new Personal System 2 computers this April. IBM's five new machines remain "open", so that independent hardware companies will be able to make add-in circuit cards to boost memory or add special features. The line was backed by $50 million in advertising. So far, the new computers have received mixed reviews.

The best received appears to be the Model 50, a desktop system that should become the basic work station in large offices. At the low end, IBM's Model 30 ($1,945) replaces the aging PC. It is expected to fare poorly against $1,000 clones. The new line poses several problems for customers. The new machines use 3.5-in. floppies, but customers must sort through several ways of shifting programs and data from old disks to new ones. Customers also have vested interests in add-in cards and other devices for their *old* machines (A $3,000 PC can easily include $1,500 worth of add-ons, none of which will work with most models of the new line). Then there's the issue of software. Microsoft Corp. isn't scheduled to deliver operating-system software until early 1988. Consequently, many analysts expect a 3-4 year lagged effect for the "classic" line before the new line really takes hold.

In early August IBM unveiled a low-priced PC aimed primarily at the educational market, setting up a battle for the school business nationwide between IBM, Tandy, and the education market leader--Apple Computer. This segment is extremely price-competitive, with producers typically offering school systems sharp discounts and even free machines.

This new machine is priced at $1,695, with built-in color monitor. As of August 5, IBM stated that 19,000 units had already been shipped to stores. Officials hope that the combination of price and features (enhanced graphics) will boost IBM's unit share of the education market, which is estimated at 7%. Apple and Tandy account for 58% and 17% of the market, respectively, according to Talmis, a New York market research firm. In addition to the education market, IBM is hoping to grab some of the home user and small business market as well. By comparison, Tandy's model 1000 TX with color monitor is priced 13% less than IBM's basic model 25.

APPLE COMPUTER

The big news with Apple in April, 1987 was the release of its new, enhanced versions of the increasingly popular Macintosh computer--namely the Mac II and Macintosh SE. These differ from their predecessor in several areas: a large color screen, more powerful graphics, and slots that give owners the freedom to expand the machine (hence the term "open Mac"). Also, Apple has never sold and supported a nonproprietary operating system. That was to change in the summer of 1987, when Apple started shipping UNIX for the Mac II. Another major development was providing IBM PC and MS-Dos compatibility for the Macintosh, via the introduction of several new products (AppleTalk card for IBM PCs, 5.25-in. floppy disk drive, file conversion software-Passport, etc.).

The Mac SE was introduced at a price around $2,600 with one floppy disk drive and $3,600 with an added 20 megabyte hard disk. The Macintosh II is the highest performance unit, and was priced at $3,500 for the basic configuration. Prices can go to $6,000-7,000 with the addition of a 40-meg internal hard disk drive, color monitor and extended video card.

Apple is cleary going after a larger share of the business market, and is winning many converts with its ease of use, speed, graphics, desktop publishing capabilites, and software. Apple states that 70% of the Macs it ships (estimated at 70,000/month) go to businesses. A survey by Kidder, Peabody & Co. (as of August 1987) shows that Mac now has 9% of the corporate market, up from 7% in December of 1986. IBM PCs and PC clones make up 85% of all PCs used in business.

An Apple marketing manager says that about 30% of Macs in business are used for publishing, but 60% are used for word processing, spreadsheets, and database work. IBM's customers are now taking Mac more seriously.

Apple is not without problems, though. The Macintosh II, its most powerful model and potentially the firm's strongest product for business, has experienced production delays as well as a shortage of color screens. The schedule for delivering UNIX operating software for Mac II, a necessity in technical and engineering markets, has fallen six months behind.

TANDY CORP.

For the year ended June 30, 1987, Tandy's computer sales jumped an estimated 23%. Now Tandy is battling Compaq and Italy's Olivetti to be the world's number 3 personal computer maker, behind IBM and Apple. But, the company faces obstacles in reaching that goal, unless it can sell more complex systems such as LANs.

Tandy has 386 computer centers where its dirct sales force works, but management would like its outbound sales program to move more quickly than it has. The company has taken a low budget approach in direct sales, making it difficult to retain good technicians who set up networks in businesses and make sure everything from printers to modems work properly. In January 1987 Tandy closed 103 computer centers and consolidated remaining outbound sales reps under the most effective center managers.

Prudential Bache Securities reported that Tandy's computer sales to end-users are divided as follows...........home users--40%, small business (under 200 employees)--32%, education--20%, Government--4%, large businesses--4%.

Thanks to a booming PC market, Tandy has had time to re-do strategic plans to reach more businesses. It remains the largest and most profitable computer retailer in the world and its production costs are among the lowest. The new line of PCs introduced in August should carry the firm into 1988, and despite competition from dozens of cheap Asian-made IBM PC clones, Tandy should dominate the home PC market during the Christmas season.

COMPAQ COMPUTER

Compaq has grown into a $625 million company (with 1987 revenues expected to hit $931 million), that is battling Apple for the number 2 spot in sales of PCs to businesses. The firm has done it by building IBM-compatible computers costing about the same but which outperform

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them or offer something extra. The **Paradigm** was Compaq's first computer, a suitcase-sized portable that led to the firm's name. It succeeded because IBM didn't have a comparable product. But IBM's introduction of the PS/2s has put the company on the defensive. The strategy is to hit the PS/2 now because Compaq doesn't have one to sell, say analysts. Many contend that Compaq is rapidly scrambling to clone the PS/2, which the company denies.

Compaq's following is in large companies, whose purchases accounted for 45% of sales in 1986. There are some 10 million IBM PCs and compatibles in businesses around the world. Compaq is betting that it won't be easy to get them to trade up to the new PS/2 line. Demand for the firm's newest model, the Portable II, is so strong that all orders will not be filled until the Fallof 1987.

Compaq's overall outlook for the next two years is positive. Its greatest strength appears to be good management. Of Compaq's 21 officers, 17 are former Texas Instruments employees. The firm has the right blend of engineering and marketing know-how, and it is the only major maker of IBM-compatiable PCs that does all its own "reverse engineering"--coming up with the electronic circuits and software that duplicate functions of the IBM PC. It has new plants in Singapore and Scotland, and will attempt to boost overseas sales from 19% to 45% of the total. Compaq has a backlog of new products to launch, including ad portable utilizing the Intel 80386 chip. Compaq's estimated share of worlwide sales of IBM and IBM-compatible PCs rose 15% to 7.5% during 1986, as IBM's share slipped from 52% to 32%.

The company is using the confusion over IBM's PS/2 to solidify its role, especially in companies that don't rely heavily on IBM mainframes. Compaq can choose either of two paths--insist that it and other imitators of IBM PCs have established their own market (risking grouping itself with the multitude of clonemakers and possible losing its distinctive position), or reverting to its original strategy of simply matching IBM move for move.

DATA GENERAL

Data General has not done well in personal computers, gambling on an innovative laptop computer built at a highly automated plant in Japan and heavily advertised. But, dim screens and the firm's lack of muscle in the

Continued............

consumer market made the machine flop. Future Computing predicts that of the 550,000 laptops to be sold this year, only 35,000 will be Data General. As the company chased such ventures, it fell further behind its mainstream markets and Digital Equipment Corp.

The firm's turnaround strategy will include recruiting more "value-added resellers" (VARs), the middlemen who add specialized features and position computers into niche markets such as law offices or brokerage houses. However, some analysts feel that Data General is too big to be a niche player and too small to be a large-scale systems supplier.

SUPERCOMPUTERS & MINISUPERS

In March 1976, Seymour Cray began the era of the vector supercomputer. Eleven years ago it was generally thought that the total market for such big, expensive machines would be just a handful of systems. Now it looks like a boom market, with the impetus coming from the need for plenty of fast computation. Sanford C. Berstein & Co. forecasts 60% annual growth in systems installations and 45% in value through 1990.

Bernstein estimated the installed base at year-end 1985 at 165 machines, and projected growth to 258 by 1986 and to 1,675 by 1990. The number of companies in the supercomputer market is also increasing considerably--including Cray, ETA, CDC, Fujitsu, Hitachi, and NEC. Industry leader Cray was estimated to capture 70% of the market in 1986, with second place going to ETA Systems of St. Paul, MN (a Control Data spin-off).

France is involved in the market as well, via Bull SA, who entered the commercial market last year. Minisupercomputers, which deliver less performance, but at far cheaper prices, have also appeared on the scene recently. Some companies in this niche include: Convex Computer Corp. (Richardson, TX), Floating Point Systems (Beaverton, OR), Alliant Computer Systems (Acton, MA), Culler Scientific Systems (Santa Barbara, CA), Vitesse Electronics (Camarillo, CA), Elxsi (San Jose, CA), and Gould Computer Systems (Ft. Lauderdale, FL).

While many computer makers got caught in the recent industry slump, Cray forged along at 50% growth rates or more annually, claiming nearly two-thirds of the market for supercomputers used for everything from weather forecasting to designing drugs. The firm's earnings last year jumped 65% to $125 million, on sales that rose 57% to $597 million.

Cray is introducing its most powerful machine ever, the Y-MP. The firm's average order was $15 million during 1986, but this is coming down to $13 million. Cray's most popular model is the X-MP, which has one-third the power of its successor. Competition lurks in the form of ETA Systems and Chopp Computer Corp., while additional firms such as Convex Computer and Alliant Computer Systems nibble away at low-end sales in minisupercomputers.

The Japanese are making an intensive effort to gain superiority as well. NEC says it already has the fastest single-processor supercomputer, and it has joined with Honeywell Inc. to market the machines in the U.S. Fujitsu Corp. also competes in the U.S. through its Amdahl Corp. subsidiary. So far, only one Japanese supercomputer is at work in the U.S., an NEC machine sold at a big discount. But, like so many other electronics markets, over the **long term** the Japanese will be a major force to reckon with.

Cray's strategy is to keep building the fastest machines possible. It plans to unveil new products every two years through 1991. The company also has an unrivaled software library, and will work to enter new industries. expanding from science labs to auto, chemical, and commercial sectors. To interest new customers Cray has a new $2.5 million machine, not much more than a minicomputer costs.

In August 1987, the U.S. and Japan were talking about a new agreement that would make it easier for American firms to sell supercomputers in Japan. U.S. Trade Representative Clayton Yeutter and Japanese Ambassador Nabuo Matsunaga agreed to simplify bidding and procurement procedures. In late 1986 the U.S. government investigated alleged supercomputer dumping by Japanese makers. The investigation has not yet been completed.

Analysts agree that Cray would benefit most from new Japanese guidelines, since it offers a much wider selection of software than Japanese competitors. Cray is estimated to capture about 15% of the Japanese market, versus 65% worldwide.

NEC offers two supercomputers, the SX-1 and SX-2. Fujitsu has the VP-50 and VP-400. France's Bull began its **Isis** supercomputer program in 1984 as a noncommercial venture, but was to have turned the project commercial when the first prototype of the Isis machine was to have been completed at the end of 1986. Isis is geared for military applications.

All of the action in supercomputing is no longer limited to the biggest, fastest and most costly machines. A new class of minisupercomputers has emerged, which offer lower performance at much lower prices. Scientific Computer Systems offers the SCS-40. Vitesse offers the Vitesse Numerical Processor, or VNP. Flexible Computer Corp. offers the Flex 32 machine.

Elxsi, a San Jose, CA company, is mounting a major campaign to make its System 6400 the leader in a new market-- **real-time supercomputing.** It expects sales to come from customers in the aerospace industry, and others with real-time applications. Elxsi's approach is to be the first to apply supercomputer power in situations where it's mandatory that the computer respond to rapidly changing conditions as they happen. To qualify as a real-time computer, a system must be able to guarantee a fast response time. But a supercomputer or mainframe's big operating system can take too much time for overhead functions, preventing real-time response.

COMMUNICATION EQUIPMENT MARKETS

Electronics, in its annual "U.S. Market Report", projected that the communications industry would grow 7% in 1987, half the rate achieved last year. Overall sales should reach $24.2 billion. In some sectors, growth is stabilizing simply because markets are maturing or nearing saturation. This is true of central-office switching systems. Total sales of telecommunications systems are expected to rise by only 2.5% to $5.85 billion.

According to Electronics,".......In the $5.9 billion market for telecommunications gear, voice-switching systems are in for a hard year. Both central-office and private-branch automated exchanges will feel the sting, flattening to a 1% growth rate each. Since it grew 32% last year, voice PABX equipment will be particularly hard-hit, a result of business buyers turning from voice-only to the latest digital PABX gear, which can send both voice and data, or keeping their voice switches and installing local networks for data communications.

Electronics predicts that PABX unit sales should be $2.66 billion for voice PABX units, up slightly from $2.61 billion last year. A 16% growth rate is forecast for **data** switching PABX systems. Other factors affecting PABX sales adversely include the large number of vendors, creating an oversupply and price cutting. Also, technology improvements have made

Continued.........

last year's designs obsolete. Big-ticket switches, central-office switches, are in a state of flux, and phone companies are changing to electronic central-office switches in order to provide equal access--a process that should be nearing completion this year.

Fiber-optic data systems are also growing substantially, contributing to downtrends in other markets such as microwave. Satellite earth stations will also feel the adverse effects.

Computer Networks

Problems are being solved, and the idea of hardware and software to connect all the computers in an office or factory is expected to catch on this year--benefitting dozens of small companies and moving this $1.5 billion market to $3 billion by 1990.

International Data Corp. analysts expect the number of networks installed worldwide to reach 220,000 this year, up from 52,000 in 1984. During the past year, Digital Equipment, AT & T, Hewlett-Packard, and Apple have introduced new network products. Tandem Computers has joined forces with Boeing Co.'s computer services division to sell factory networks, and IBM has also joined the ranks.

Networks allow workers at one location to share information, peripheral equipment, and programs with co-workers in the adjoining office and around the world. Novell Inc. and 3Com Corp. are the leaders in the market for networks consisting of personal computers. They are gearing up to provide complete systems. DEC is the leader in networks that tie terminals to large minicomputers. Ungermann-Bass Inc. is a supplier with $111 million in sales, and is a direct competitor of DEC.

Following is a breakdown of the leaders in networking, according to IDC...

(1986 Shipments - Thous. of Systems)

TERMINAL NETWORKS		PC NETWORKS	
Digital Equipment	3,750	Novell	8,700
Proteon	1,220	3Com	8,200
Wang	850	IBM PC Net	7,500
Xerox	750	IBM Token-Ring	1,200
Ungermann-Bass	450	Fox	3,800
		Orchid	3,150

THE ELECTRONIC MODEMS & MULTIPLEXORS MARKET

RECENT PERFORMANCE OF DATA PROCESSING EQUIPMENT MARKETS

	---------- SALES ($ Millions) ----------			
	1985	1986	1987	Avg. Yearly Growth 1985-87 (Percent)
Total Computer Systems	$40,610	$44,663	$49,785	11.3
Personal Computers	10,434	11,655	13,280	13.6
Technical Work Stations	1,008	1,627	2,200	59.1
Multiuser Microcomputers	3,620	4,000	4,472	11.8
Minicomputers	2,267	2,282	2,341	1.6
Superminicomputers	7,557	8,452	9,593	13.5
Minisupercomputers	125	200	307	72.8
Mainframes	15,180	15,863	16,656	4.9
Supercomputers	419	584	936	61.7

SOURCE: ELECTRONICS' 1987 U.S. MARKET REPORT (1/8/87)
MARKETDATA GROWTH CALCULATIONS

THE ELECTRONIC MODEMS & MULTIPLEXORS MARKET

RECENT PERFORMANCE OF TELECOMMUNICATIONS SYSTEMS MARKETS

	--------- SALES ($ Millions) --------			
	1985	1986	1987	Avg. Yearly Growth 1985-87 (Percent)
Total Telecommunications Systems	$4,798	$5,708	$5,850	11
Total Data-Switching Systems	248	273	314	13.3
Central Office	86	95	106	11.6
PABX	162	178	208	14.2
Total Voice-Switching	4,550	5,435	5,536	10.8
Central Office	2,570	2,820	2,876	5.9
PABX	1,980	2,615	2,660	17.2

SOURCE: ELECTRONICS, 1987 U.S. MARKET REPORT (1/8/87)
MARKETDATA GROWTH CALCULATIONS

MARKET SHARE ESTIMATES - THE TOP LEADERS IN THE MODEM & MULTIPLEXER MARKET

ESTIMATION METHODOLOGY

Estimating company market share is always difficult, since the researcher is dealing with imperfect information from a variety of sources. For some companies, exact modem or multiplexer sales are known if they are publicly-held and that is their only business. Their sales can be obtained from annual reports, 10K SEC statements, and various investment services such as Moody's, Standard & Poors, and Value Line. This is the "purest" form of information, but is usually the exception rather than the rule.

More often, companies are subsidiaries or divisions of larger parent firms (such as Codex and Universal Data Systems-part of Motorola). In this case, sometimes the individual company contributions to sales and profits will be disclosed if the parent is publicy-held. Other times, divisional results are "buried" in groups or business segments. If the firm is privately-held, no public financial information is available (Hayes). These firms' sales are the most difficult to estimate.

Marketdata has used the following sources to obtain sales data, and ultimately to derive share of market estimates.........company product catalogs, annual reports, 10K statements, Value Line, Moodys Investors Service, Standard & Poor's stock sheets, Thomas Register, trade journal and magazine articles, and electronics industry analysts, editors and experts. We also considered the number of workers employed by the company, and the frequency and depth of its advertising in electronics directories and journals. Company sales were divided by the estimated $2.0 billion combined market for modems and multiplexers in 1987. We considered only company **equipment** sales, not leasing/non-equipment revenues.

We estimate that the Top 4 companies capture 51% of the market, a fairly high concentration ratio. The top 10 are estimated to capture 82%, and the top 13--nearly 89%. Marketdata estimates that Racal's two U.S. divisions, Racal-Vadic in California and Racal-Milgo in Florida combined capture 22% of the market ($445 million in fiscal 1987 sales), and are the market leaders. Hayes, privately owned, is the industry pioneer and has the quality reputation, brand recognition and PC end-user installed base and experience to justify it as number two,

Continued............

with 11% of the market, followed closely by Paradyne and General DataComm. Marketdata welcomes any comments concerning the validity or verification of these estimates by modem/multiplexer manufacturers that dispute them.

ESTIMATED SHARE OF MARKET - 1987
SHARE OF COMBINED MODEMS & MULTIPLEXERS MARKET

COMPANY	SHARE OF MARKET
1) RACAL-MILGO & RACAL VADIC, COMBINED	22.3 %
2) HAYES MICROCOMPUTER PRODUCTS	11.0
3) PARADYNE CORP.	9.1
4) GENERAL DATACOMM INDUSTRIES	8.9
TOP 4 FIRMS:	**51.3**
5) AT & T	8.5
6) GANDALF TECHNOLOGIES	6.5
7) CODEX CORP. (MOTOROLA)	4.5
8) TIMEPLEX	3.9
9) UNIVERSAL DATA SYSTEMS (MOTOROLA)	3.8
10) M/A COM	3.8
TOP 10 FIRMS:	**82.3**
11) ROCKWELL INTERNATIONAL	3.8
12) EMULEX	3.8
13) ANDERSON JACOBSON	1.2
TOP 13 FIRMS:	**88.8 %**

Other companies that probably capture the bulk of the remaining 11 % or so of the market include.........Bo-Sherrel Corp., ComDesign, Inc., Amdahl Communications Systems, Prentice Corp., Kinex Corp., Plantronics, Digi-Voice, Penril Data Communications, Concord Data Systems, Scientific Atlanta, and Digital Controls Corp., Fujitsu and NEC.

1987 MODEM USER SURVEY -THE INSTALLED BASE, BY VENDOR

Data Communications' September 1987 issue reported the results of Datapro's 1987 modem user survey, in which modems were evaluated for: ease of installation, diagnostic capabilities, hardware reliability, the manufacturer's maintenance/service/technical support, and overall performance. A total of 1,363 responses were obtained from users of dial-up and leased-line modems, 254 responses for fiber optic and limited distance modems. The number of installed devices represented totalled 125,995 for the former and 12,623 for the latter.

Based on this survey, users seem to be satisfied overall, with the modem technology now on the market. Users were not overwhelmingly satisfied with the diagnostic capabilities, however. The category carrying the highest overall ratings was hardware reliability. The fiber optic modem market is starting to come alive, but is still hampered by the lack of standards, an issue that must be resolved before this segment really becomes lucrative.

Datapro reports that the top 10 vendors' products together comprise over 80% of the **installed base** of dial and leased-line modems, as follows.......

PERCENT OF MODEM INSTALLED BASE, BY VENDOR

AT & T		19.9 %
CODEX		11.5
UNIVERSAL DATA SYSTEMS		9.6
PARADYNE		9.6
GENERAL DATACOMM IND.		9.4
RACAL-MILGO		8.1
RACAL-VADIC		4.6
CASE		3.7
CONCORD DATA		2.3
IBM		2.0
HAYES		1.7
	Subtotal:	82.4
ALL OTHERS		17.6

HIGH-VOLUME USER RESULTS

Rated Top-10 Vendors	Avg. Number of Modems Per Respondent User
AT & T	154
Universal Data Systems	151
General Datacomm	140
Case	133
Paradyne	117
Racal-Milgo	107
Codex	86
Racal-Vadic	65
IBM	43
Hayes	16

ANDERSON JACOBSON

Anderson Jacobson designs, manufactures, sells and leases a variety of data communications equipment, including modems (4048, 9601, others), multiplexors, data switches and computer terminals. For the past two fiscal years, following is a breakdown of revenues by type.......

	1985-86	1984-85
Sales	59%	47%
Lease & Service	41	45
R & D Contract	Nil	8

European operations accounted for about 33% of total sales in 1985-86. The company's customers for data communications equipment and terminals include a wide range of industrial firms, financial institutions, and government agencies. Products are designed as standard models available "off-the-shelf". A fully integrated voice and data communications switching system was introduced in September 1984 for the Private Branch Exchange (PBX) business telephone market. The system, called the IOX Integrated Office Exchange, is modularly expandable.

In 1985, the company agreed to pay nearly $8 million for 100% ownership of a joint venture formed in 1984 to research the system with Diversified Technology Partners Ltd. During 1986, Anderson Jacobson introduced nine new products, including new modems, statistical multiplexors, and digital data switches. Total revenues for the six months ended September 30, 1986 declined 1.9% over the prior year, as a 12% sales gain was outrun by a 19% drop in lease and service revenues. Following is a six-year analysis of the company's financial position...............

	Sales ($ Mill.)	Net Income ($ Mill.)	Net As % % Sales	Capital Expend. ($ Mill.)	Current Ratio
1980	$41.4	$2.2	5.3	$3.61	1.9
1981	49.5	1.75	3.5	5.77	2.4
1982	50.3	0.91	1.8	0.79	1.8
1983	52.8	1.90	3.6	9.91	1.1
1984	51.1	(3.21)	NM	9.62	1.3
1985	46.6	(2.77)	NM	3.08	1.2
1986	39.0	(3.17)	NM	1.13	2.1

CODEX CORP.

Codex is another subsidiary of Motorola and is headquartered in Canton, MA. It makes the Codex 2260 modem that supports full-duplex 9600 bps operation, and falls back to 4800 bps. This unit supports the Hayes AT command set, as well as its own Codex Verbose command set. Other lines include the.....CS series, LSI series, MX-2400, 2233, 2280, 2300 series, 2600 series, 5208R, and 5212, as well as the LDSU 8250 and 21XX series fiber optic and limited distance modems.

The company has been in the "networking" business for 25 years, and claims to have sales offices in more than 40 countries worldwide.

Exact company sales are not available, but the Thomas Register lists Codex in the $50+ million class. Motorola's "Information Systems" group (consisting of multifunction computer systems, high -speed modems, multiplexers, network processors, local area networks and related integrated equipment) accounted for 8% of total 1986 sales of $5.888 billion, or $471 million for the Information Systems group. Codex sales are some percentage of this figure. Group profits were $75 million. Codex and Racal Milgo also are approximately equal in their share of the $120 high-speed modems segment. Assuming that they each take 35% of this market, together controlling a majority 70%, then this would put Codex sales at an estimated $42 million at the minimum, close to Thomas Register's estimate.

In the high-speed area, it make a V.32 modem that uses VLSI technology and forward error correction (Trellis Coded Modulation), sending data at up to 9600 bps full duplex over ordinary dial lines. It also has a proprietary long haul echo cancellation feature, soft strap front panel, multiple ACUs, a nest card option for maximum space savings, and operates in synchronous or asynchronous applications.

GANDALF TECHNOLOGIES, INC.

Gandalf is a Canadian holding company with subsidiaries in Canada, the United States, and the United Kingdom. The firm was reorganized under its present name on August 1, 1981 to consolidate three separate corporations, including Gandalf Data Communications Ltd., which was incorporated in 1971. Its stock is traded-over-the counter in the U.S.

Continued.........

Gandalf manufactures digital data communications equipment that links computers terminals to telephone lines and each other. Its principal products include: local data sets, modems, private automatic computer exchanges (PACX), and private intelligent networking devices. R & D accounted for 12% of 1986 revenues, and the company employs 1,360 workers.

The company, according to Value Line, seems poised to post record earnings in both fiscal 1987 and 1988. Gandalf was scheduled to boost its equity base by offering two million newly-issued shares. The expected proceeds ($24 million) were to be used for reduction of short-term debt and general corporate purposes. Despite operating in an industry noted for product oversupply and fierce price competition, Gandalf's sales continue to grow about 25% per year, and its profitability is strong.

Sales in the competitive U.S. market ***are*** growing slowly, but this is more than offset by strength in the company's Canadian and European operations, where sales are rising at double-digit rates, on the basis of Gandalf's excellent penetration of the market for LANs.

Following is an analysis of the firm's financial position since 1981.........

	Sales	Net Profits	Net Profit Margin
	($ Million)		
1981	$40.2	$4.1	10.2 %
1982	53.3	6.7	12.6
1983	58.6	3.7	6.3
1984	69.1	5.0	7.3
1985	85.8	3.2	3.8
1986	107.8	3.3	3.1
1987 *	130.0	6.0	4.6
1988 *	155.0	8.5	5.5

* Value Line Investment Survey estimates

GENERAL DATACOMM INDUSTRIES

General DataComm manufactures data communications equipment and networks, including modems, multiplexers, and network management systems. In the past, the company was involved in both the regulated and deregulated marketplace, with sales evenly distributed over three segments- common carrier, business systems, and international markets.

In fiscal 1981, following regulatory changes in the industry, common carrier sales fell and the company shifted, increasing sales efforts towards domestic end-users in the business systems area. GDC now serves a broad base of business systems customers, as well as common carriers and government agencies. International sales accounted for 23% of the total in fiscal 1986, compared to 20% during fiscal 1985.

Important recent developments include the March 1987 action to sell for $40 million its network services and corporate facilities, to be leased back with an option to repurchase at a later date. Earlier, General DataComm announced a 3-year contract estimated to be worth $30 million, to supply specialized equipment to the member companies of Telecom Canada. Separately, the firm reported that it was encouraged by its 1986-87 first quarter results, and was pleased with initial market acceptance of **Megaswitch**, its state-of-the-art switching multiplexer, which it began shipping at the end of the quarter.

Sales are expected to gain sharply during fiscal 1987, reflecting some strengthening in data transmission markets, increased penetration of new products, and aggressive sales and marketing. Margins are expected to improve on higher volumes, and as a result of cost controls. Sales for the quarter ended Dec. 31, 1986 rose 27%, year-to-year. During the first quarter of fiscal 1987, GDC repurchased 229,400 of its shares, at an average price of $8.40 each.

Following is a financial summary of General DataComm since 1980.........

	Sales	Net Income	Capital Expend.	Return On Assets	Current Ratio
	($ Millions)		($ Mill.)		
1980	$54	$4.4	$3.5	9.2 %	2.9
1981	58	1.8	12.3	2.9	3.7
1982	61	(1.2)	6.6	NM	3.3
1983	86	3.5	6.5	3.7	4.0
1984	146	11.3	40.0	9.2	3.6
1985	184	10.8	22.3*	6.3	4.5
1986	178	3.9	16.0*	2.1	3.6

Note: Results are for years ended Sept. 30.
*Net of current year retirement and disposals
NM - Not meaningful   Parentheses indicate loss

HAYES MICROCOMPUTER PRODUCTS

Hayes, of Atlanta, GA, is undoubtedly one of the industry's pioneers and leaders, producing data communications devices for nearly a decade. The firm was a pioneer in microprocessor controlled modem technology and produced some of the first direct-connect, easy-to-install modems for personal computers. It was the first modem manufacturer to offer a 2-year limited hardware warranty, and now offers an optional 4-year warranty. The company is privately-held, therefore no financial data is available.

Hayes is attempting to address the problem of achieving synchronous compatibility by promoting a new standard via introduction of the Hayes Synchronous Interface (HSI)--a set of conventions that software developers can use in designing software so that synchronous communication applications are isolated from the differences among various hardware implementations. No one synchronous interface adapter has achieved a degree of popularity comparable to that of the IBM Asynchronous Interface Adapter, so general compatibilty between today's synchronous hardware and software does not exist. Hayes has placed the HSI in the public domain for use by interested developers.

Following is a review of the company's main product lines..........

Smartmodem 300--for use by home computer enthusiasts, for inter-office communications, or any other type of data transfer (0-300 bps)
Micromodem IIe/Smartcom I--plug-in telecomputing system for Apple IIe (110 or 300 bps board modem)
Smartmodem 1200--dials, answers, disconnects calls automatically and works at both full or half duplex over dial-up phone lines. Bell 103/212A compatibility, CCITT compatible for full duplex synchronous international communications at 1200 bps. Operates at 300 and 1200 bps, automatically adjusts to incoming data speed.
Smartmodem 1200A--for Apple IIgs, Apple IIe, Apple II+, or Apple II (0-300, 1200 bps), call progress monitoring, self-test, AT command set, voice/data transmission. optional speeds, auto dial/answer, etc.
Smartmodem 1200B--half-card size, 1200 or 0-300 bps communications with other computers, databases, information services, bulletin boards.
Smartmodem 1200C--specially designed for use in IBM PC Convertible, plus into sytem's option slot. Needs no external power supply or serial card, features low power consumption.

Smartmodem 2400--combines high data transmission rates with ease of use and flexibility, communicates in traditional asynchronous personal computer environment and the synchronous mainframe environment. Hayes AutoSync enables it to place a call from an asynchronous terminal, then switch to synchronous communication. Optional sppeds: 2400, 1200, 300 bps.

Smartmodem 2400B--capability to communicate synchronously to a mainframe or value-added network through a standard personal computer communications port.

V-Series Smartmodem 9600, 9600 B--can send and receive data across dial-up or conditioned leased lines at 9600 bps and achieves up to 19,200 bps throughput with adaptive compression. Fast turnaround "ping-pong" operation, error-control, forward error-correction. Used for IBM AT or 100% compatible PCs.

V-Series Smartmodem 2400, 2400B--in addition to functions of regular 2400, also provides error-control, increased throughput with adaptive compression, can achieve up to 4800 bps effective throughput. Can be used with IBM PC, XT, AT or 100% compatible.

V-Series Modem Enhancer--an external unit that resides between your PC and Hayes Smartmodem 2400 or 1200, adds V-series features to regular Hayes modems.

Transnet 1000-provides both print buffering and an electronic mailbox in one device, available with 128K or 512K RAM. A standalone modem, printer, and Transnet 1000 can operate without being connected to a computer and can serve as a mailbox.

Smartcom I, II communications software--for Apple II, Macintosh computers, Smartcom II Version 3.0--for IBM PC and compatibles, and IBM Token Ring PC network.

PARADYNE CORP.

Paradyne designs, manufactures, sells and services data communications equipment and systems which primarily facilitate the rapid transmission of data between computers, via telephone lines. Contributions to total revenues by main business segments for recent years were as follows........

	1985	1984	1983	1982
Equipment Sales	72 %	79 %	77 %	82 %
Maintenance/lease revenues	28	21	23	18

Foreign sales accounted for about 16% of sales during 1985, compared to 13% the prior year.

The company's main product lines include the following.........Medium and high-speed modems-- designed for the transmission and reception of data mainly from 1,200 to 19,200 bps, available in diagnostic and nondiagnostic configurations, Network Management Sysytems--the firm's **ANALYSIS** network diagnostic and management system monitors, analyzes, and reports critical network performance information in order to expedite the detection and correction of problems to restore the network to operation, and **PIX** (parallel interface extenders) communications systems--designed to improve efficiency for remote users of IBM computers.

Its line of modems includes...........the Challenger, Fox, LSI, MP, MPX, MPX 4800, MPX 9600, and VHS series, and the T96 and HDX 9600, as well as fiber-optic devices.

A major development in March, 1987 was that fraud charges against Paradyne and eight of its officers were settled when the firm pleaded guilty to conspiracy, agreed to pay $1.2 million in fines and costs, and removed Robert Wiggins as chairman and president. All other charges against Paradyne in Tampa, Florida federal court were dropped, as were all charges against four of the defendants. Charges against Mr. Wiggins and three others were deferred under a pre-trial diversion program, and were to be dropped after one year upon successful completion of the program. The Federal government agreed to dismiss its civil false-claims suit against the company and lift its suspension of the firm as a Federal contractor. Paradyne also agreed to settle related derivative and shareholder suits by paying about $8.1 million.

All of these legal woes have taken its toll on the company. According to an April 6, 1987 article by Business Week, the company still remains among the top five suppliers in the modems market, but it has slipped to number two in the $120 million market for high-speed devices, ceding the number one spot to Codex Corp. (Motorola subsidiary) and Racal-Milgo. Paradyne is no longer the leader in technology, market share, or price.

The company's new chief executive is Jerry T. Kendall, a 43 year old executive whose background is primarily in marketing. He has had to struggle with rebuilding the company's morale, product strategy, and recent heavy losses. Kendall is easing out of computers to concentrate on

Continued.............

modems again, and faces challenges to get into the fast-growing T-1 multiplexor market that Codex is taking advantage of. Progress has been made. Over the past two years he has revamped accounts receivable and billings systems, written down $20.6 million in inventory, cut the workforce 20% to 3,400, and reduced debt from $137.6 million in 1985 to $93 million, resulting in a positive cash flow. Kendall hopes to introduce Paradyne's version of a T-1 multiplexor sometime this year.

According to Value Line, revenues for 1986 (preliminary) rose 3.4% year-to-year, limited by continuing softness in the electronics industry. Despite the capitalization of software development costs and ongoing efforts to reduce expenses, a $9 million 1986 provision for legal and/or settlement costs led to a pre-tax loss of $37.6 million. Following is an analysis of Paradyne's financial position since 1980..........

	Sales	Net Income	Net As % Sales	Capital Expend.	Current Ratio	Return On Assets
	($ Million)			($ Mill.)		
1980	$76	$8.3	10.9	$21.9	3.9	12.6
1981	135	17.5	12.9	46.6	2.5	12.9
1982	207	26.9*	13.0	60.3	4.2	12.4
1983	209	3.7	1.7	31.7	4.2	1.4
1984	290	11.0	3.8	53.3	4.3	3.5
1985	253	(31.2)	NM	45.1	6.1	NM

NM-Not meaningful * Reflects accounting change

As of August 26, 1987, a unit of Saul Steinberg's Reliance Group Holdings Inc. said it holds a 7.4% stake in Paradyne, purchased for investment purposes. The group said it holds 1,690,400 shares of Paradyne common, including 1,435,800 purchased from August 14-17 for $8 to $8.25 a share.

Paradyne said it has about 22.9 million common shares outstanding on a fully diluted basis. The Wall Street Journal reported that Mr. Steinberg, a New York investor who is chairman and chief executive officer of the two Reliance companies, may eventually attempt a takeover.

RACAL ELECTRONICS PLC

Racal Electronics is the world's largest data communications company, 30 years old, based in Britain, and having 1987 sales in excess of $2 billion.

Continued..........

The company offers a broad product line, ranging from simple modems for PCs, multiplexers and LANs, through to powerful packet switching systems, with network management to oversee the entire installation.

Following is a breakdown of Racal's major business areas, and geographic analysis of sales, for 1986 and 1987...........(percent of total sales in parentheses)

	1987	1986
TOTAL SALES ($ 000)	$2,065,355	$2,026,130
Security	632,184 (30.6%)	570,014 (28.1)
Data Communications	445,401 (21.6)	433,970 (21.4)
Radio Communications	210,379 (10.2)	294,957 (14.6)
Defense Radar & Avionics	203,061 (9.8)	210,215 (10.4)
Marine & Energy	176,315 (8.5)	210,947 (10.4)
Telecommunications	109,930 (5.3)	55,301 (2.7)
Specialized Businesses	288,085 (13.9)	250,726 (12.4)

GEOGRAPHIC ANALYSIS OF SALES

	1987	1986
Africa	5 %	5 %
The Americas	23	25
Asia & Australasia	15	17
United Kingdom	40	39
Europe (exc. U.K.)	17	14

Racal's Data Communications division's principal activities/products include............corporate data networks, data communications equipment/systems, data encryption devices, voice & data digital communications products, local area communications, network management, image processing systems, and turnkey data networks.

Continued..............

The firm maintains over 280 parts and customer support centers in North America. As evidence of its expanding product line and movement into the fast-growing LAN market, its **PLANET** system has been installed in organizations as diverse as the U.S. Navy and Colonial Penn Insurance Co.

Racal operates two data communications companies in the U.S.--Racal-Milgo (Sunrise, FL) and Racal-Vadic (Milpitas, CA). The company reports that the data communications group had an excellent year, improving profits from 15,054,000 (British pounds) to 44,076,000 from 1986 to 1987. It was the largest contributor to Racal's operating profits, and is expected to remain so this year.

Racal-Milgo increased both sales and profits, and is investing heavily in the next generation called **SUNRISE,** giving it technology needed to win large systems contracts. Further orders for this type of business include one from American Airlines for their SABRE seat reservation system and a contract for $11 million from the Social Security Administration for a national data network. Racal-Milgo (UK) continued its good performance, with orders from the Is Bank in Turkey, Hertz vehicle rentals and AP Dow Jones Telerate network. The company has embarked on a program of strategic acquisitions, joint ventures, and formation of new subsidiaries.

Racal-Vadic had a 10% sales increase, and returned to profitability. In the U.S. market, it is addressing demands for higher speed data transmission over public phones lines, and internationally a new product range will maintain the company's leading supplier position in low-medium speed dial-up modems. IBM has asked the firm to develop and produce modems for their CONVERTIBLE PC and new range of PCs. Other major orders were received from Mastercard International and the Johnson Space Center in Houston.

Early in 1986, Racal-Vadic shipped its two millionth modem. The company began in 1969 as Vadic, in Los Altos Hills, CA. In 1978, Racal Electronics of Britain bought Vadic, creating the world's largest modem company. Racal-Milgo and Racal-Vadic together serve customers in 120 countries and produced 1986 revenues approaching $500 million. Each company operates autonomously. Racal Vadic operates 11 regional sales offices (San Francisco, LA, Denver, Dallas, Chicago, St. Louis, NY, Boston, Washington, DC, Hartford, Philadelphia).

Vadic's major product lines include...........Standalone Modems, Maxwell *Modem Series, MDS I System for Rack-Mount Modems, MDS II Advanced*

Continued...............

Rack-Mount Modem System, and Multiplexers & Data Compressors (7400 series). In 1985 the firm introduced new modems with such features as AT dialing protocol, MNP error control, etc. Modem speeds up to 9600 bps are offered.

During the year the Data Communications group formed a new company, Racal Imaging Systems Ltd., to enter the optical disc-based document storage and retrieval market. This company has already supplied equipment to the British government, Prudential Assurance Co., and British Telecom.

TIMEPLEX, INC.

Timeplex is a leading manufacturer of high performance data communications equipment and a supplier of data communications systems. The company's products include: data multiplexors, network and facilities management systems, packet assemblers and disassemblers, and modems. Data multiplexors account for the bulk of sales. Foreign sales contributed 34% of total sales in fiscal 1986, and sales to U.S. Government agencies accounted for 5%.

Dun's Business Rankings reports that Timeplex employs 745 workers, 150 at its Woodcliff Lake, NJ facility. Dun's also reported that the company's sales were $66 million, lower than the figures reported by Standard & Poors in the table below.

The **Microplexor** line of statistical multiplexors is a major product line. The **Link** family of products, an important line of facilities management systems, integrates network management processing and time division multiplexing functions for the rapidly growing class of high-speed data transmission facilities known as T-1. Initial product shipments began in fiscal 1984.

Standard & Poors reported that sales for the quarter ended Sept. 30, 1986 increased 15%, year to year, while margins narrowed and pre-tax income fell 15%. No cash dividends have ever been paid. Following on the next page an analysis of the company's financial position since 1980.

Continued............

	Sales ($ Mill.)	Net Income ($ Mill.)	Net Income As % Sales	Capital Expend. ($ Mill.)	Current Ratio	Return On Assets
1980*	$18	$1.41	7.9 %	$3.8	2.1	13.2 %
1981	30	1.74	5.7	3.7	4.9	6.7
1982**	32	1.76	5.5	7.8	4.7	5.0
1983	44	3.44	7.9	8.7	5.4	5.6
1984	66	5.67	8.6	7.9	7.1	6.1
1985	96	9.99+	10.4	20.4#	5.3	8.2
1986	119	9.56+	8.0	21.2#	4.2	7.2

* Reflects merger or acquisition ** Excl. discontinued operations
# Net of current year retirement & disposals
+ Reflects accounting change

UNIVERSAL DATA SYSTEMS (Motorola Subsidiary)

Universal Data Systems, part of Motorola's Information Systems Group and based in Huntsville, Alabama, operates district offices in 20 states and Ontario, Canada (AL, AZ, CA, CO, FL, GA, IL, MA, MD, MI, MO, MN, NC, NJ, NY, OH, WA, WI). The company offers a V.33 modem ($2,995) for private line point-to-point systems, a 14.4 A/B modem ($2,995), a statistical multiplexer ($3,995), and a time division multiplexer ($3,495). Its main **modem** lines include.......the 103, 201, 202, and 212 series, as well as the 208 A/B, 9600, and 9600 A/B.

UDS **multiplexers** available include time division (six-channel), integrated into a single package with a V.33 compatible 14.4 kbps modem. The 14.4 model offers alternate data rates of 12 kbps and 9.6 kbps (V.29). With the A/B version, users can switch between private line and dial-up communications at 14.4 kbps.

CHRONOLOGY OF NEW PRODUCT INTRODUCTIONS AND COMPANY DEVELOPMENTS MODEMS & MULTIPLEXERS: 1986 & 1987

The following section presents a variety of new product and technology developments concerning modems and multiplexors, taking place from January 1986 to September 1987. Information was obtained from Electronics, Electronic News, and other trade publications.

SEPTEMBER 1987

FIBER-OPTIC MULTIPLEXER QUADRUPLES CHANNELS ON ONE DUPLEX CABLE -- Pilkington Communication Inc.'s model 3128 fiber-optic time-division multiplexer is said to quadruple the number of channels available over a duplex fiber-optic cable, by interfacing with four IBM 3174 or 3274 communications contollers instead of one. Each of the cluster controllers handles up to 32 terminals. The model 3128 handles cable faults by performing automatic rerouting and can distribute messages among the controllers, says the Simi Valley, CA firm. It also interfaces with the Telex 274 controller. It is priced at $2,650 and up.

AT & T ISDN CHIP REPLACES A BOARD-LEVEL PRODUCT, COSTS 75% LESS -- AT & T's newest addition to its integrated services digital network product line replaces a board-level product that requires far more space and costs at least 50-75% more than this single-chip solution. The T7252 interfaces a digital local switch, PBX, multiplexer, or concentrator to ISDN, an evolving system that will tie voice, data, and video signals into a single high-speed digital network. Another advantage the T7252 offers designers is versatility. While the board products had to be customized for each given switch, the T77252 is fully programmable, allowing it to be used with equipment from multiple vendors. The T7252 costs about $14.50 in 1,000-unit lots.

ADAC OFFERS MULTIPLEXER EXPANDERS -- ADAC Corp. of Woburn, MA introduced three 16-channel signal conditioning multiplexer expander modules said to provide 3-wire and 4-wire measurement, bridge completion and amplification for data acquisition and control purposes with a variety of devices. The new 4012CSEX, 4012BGEX and 4012AMEX modules are part of ADAC's 4000 series signal-conditioning system. Prices start at $1,000 per module. The new devices can be used with RTDs, strain gages, accelerometers, and other kinds of transducers.

Continued..........

COMTEN EXITING MODEM, PRIVATE X.25 MARKET -- NCR's Comten subsidiary is getting out of the modem and private X.25 networking equipment markets. Comten said it stopped manufacture of modems in late August and will cease taking orders for units in inventory on Sept. 15. Comten said it was dropping the two lines to concetrate on its bread-and-butter IBM-compatible front-end communications processor market, where return on investment is higher than the modem and private X.25 areas. Comten promised to maintain its 5-year warranties on modems in the field. The firm's modem line consisted of four models marketed under the Commander trade name--models 7160-0100C, 7160-0200C, 7165-C, and 7166-C. Single-quantity prices ranged from $2,995 to $3,995. Comten introduced its first modems in March, 1983. Although no sales figures were available from the company, industry sources indicated that it was not a major factor in either market.

AUGUST 1987

LOCAL NETS CAN TRANSMIT UP TO 2400 FT. WITH EXAR TRANSCEIVER CHIP SET -- Local area networks using either a star or bus topology can triple their maximum transmission distance with Exar Corp.'s transceiver chip set, as far as 2,400 ft. for the star and 1,600 ft. for the bus. Designed to support Starlan controllers such as Intel's 82586 and 83588, the two-chip Exar set achieves its performance advantage by segregating appropriate functions on one bipolar analog chip and one CMOS digital chip, instead of opting for a bipolar single-chip solution. Exar, based in San Jose, CA, says that segregating the functions leads to line-reflective indexes two to three times lower than competing systems. The digital CMOS XRT82C516 contains Manchester encoding and decoding logic, clock and compare circuitry, collision detection, carrier sensing, and transmission control logic. The analog bipolar XRT82515 contains variable-gain and summing amplifiers, filters, level detectors, and phase comparator circuitry. As of August 20, each chip set cost $17 in 1,000-unit purchases.

NEW THOMAS & BETTS FIBER-OPTIC MODEM -- The RS-232-C fiber-optic modem links data communications equipment and data terminal equipment with fiber-optic cable. The new modem can accomodate duplex or glass fiber-optic cables and handle data rates up to 19.2 bps. In addition to transferring data in both directions, the modem also provides support for six contol/handshake lines. It can be powered directly through a

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DB25-pin connector or external plug-in jack power supply and comes with either male or female contacts. The modems are priced at $54 in lots of 500, for glass fiber, and $36 in plastic.

JULY 1987

AT & T DATAPHONE II LINE ADDS 4 MODEMS -- AT & T of Morristown, NJ has added four modems to its Dataphone II series, including its first 9,600 bps dial-up modem for standard telephone lines, the 2296A. The firm also brought out its Dataphone II 48/96 Shared Diagnostic Unit (SDU) that enables modems to interface with the Dataphone II network system. The 2296A provides full-duplex, synchronous or asynchronous transmission at 4,800 and 9,600 bps over standard phone lines and conforms to the CCITT's V.32 standards. It can operate over 4-wire private-line networks. Pricing begins at $2,500. Another new entry, the Dataphone model 2192A, was said to be capable of full-duplex, synchronous data transmission over private-line channels at up to 19,200 bps and of automatically diagnosing faults anywhere in its connected network. It is priced at $9,500. The remaining two modems are different versions of the same unit. The 2224G can be mounted while the 2224CEO is a stand-alone modem. Both provide full-duplex communications, and operate synchronously at 300, 1,200, and 2,400 bps and asynchronously up to 2,400 bps. The 2224G costs $650 and the 2224CEO, $695. The Dataphone II 48/96 SDU lists for $625.

MICOM UNVEILS VOICE/DATA MULTIPLEXER -- Micom of Simi Valley, CA, entered the digital wideband market with the introduction of a 56K-bps integrated voice/data multiplexer, the Oneliner. It is the first Micom product that uses the firm's Advanced Packetized Voice Technology (APV), designed for users who want to integrate voice and data communications but whose systems are not large enough to use more expensive T1 rates and equipment. Voice transmission is possible at data rates of 9.6K bps instead of the standard rate of 64K. The Oneliner multiplexes multiple synchronous and asynchronous data channels and up to four 9.6K-bps voice channels over one 56K-bps digital circuit. Prices start at $4,635. The unit is the first of a series of voice packetization products it plans to introduce for the digital wideband market.

EMULEX 14.4-KBIT/S MODEM TO COST THE SAME AS 9.6-KBIT/S PRODUCTS -- Computer products specialist Emulex Corp. broke into the communications hardware market with a 14.4-Kbit/s

Continued..........

modem that offers a 50% performance advantage over the 9.6-Kbit/s modems now standard for leased-line transmissions. A proprietary CMOS six-chip set is the key factor bringing the Performance 1000 full-duplex modem in at $1,795--about the same price as the 9.6-Kbit/s modems, claims the Costa Mesa, CA company. The chip set also delivers a 50% reduction in component count, contributing to an 8.5-by-11-in. footprint for the 2.5-in.-high modem--the smallest available at 14.4 Kbits. The modem also features menu-driven operation monitored by a liquid-crystal display. The modem conforms to the CCITT V.33 standard. A 9.6-Kbit/s version conforming to the V.29 standard sells for $1,295.

GE/RCA SOLID STATE OFFERS QUAD TWO-INPUT MULTIPLEXERS -- Two quad two-input multiplexors, the CD54/74AC/ACT157 and CD54/74AC/ACT158, are being offered by GE/RCA Solid State, Somerville, NJ. Both are pin-, function- and performance-compatible with S, AS and FAST devices and are designed to replace bipolar ICs in bipolar and mixed bipolar/CMOS systems. The multiplexors select four bits of output data from two-input sources. Output logic levels of the AC/ACT157 types are non-inverted, while output logic levels of the AC/ACT158 devices are inverted. A select control input is provided, that determines which of the two inputs is gated through to the output. Propogation delay time from input to output is 4.3 ns for the AC157 and 3.8 ns for the AC158. Prices begin at 96 cents in quantities of 100. The devices operate over a supply voltage range of 1.5-5.5 Vdc. CD54AC/ACT units operate over the full military temperature range of -55 degrees C to 125 degrees C. The CD74AC/ACT versions are available in 16-lead DIPs (E-suffix) and 16-lead dual-in-line plastic surface-mount packages (M-suffix).

JUNE 1987

STANFORD TELECOM HAS PROBLEMS WITH MODEM SUBCONTRACT -- Stanford Telecommunications Inc. of Santa Clara, CA was experiencing difficulties in the final implementation of requirements for production of a modem for a U.S. government satellite communication system. It was having problems designing boards for the modem, which it is producing under a subcontract from Ford Aerospace & Coomunications. These problems contributed to lower first quarter earnings.

PARADYNE BREAKS INTO T-1 MULTIPLEXER MARKET -- Paradyne Corp. entered the T-1 multiplexer market by introducing a nodal processor, the 3230, which it is marketing under a 1985 OEM agreement with

Continued.................

Spectrum Digital Corp.. It provides circuit switching for high-speed digital facilities including North American T-1 or international networks. The 3230 supports 508 voice and data ports per node and eight non-blocking trunks at 1.544M bps, or up to six 2.048M-bps aggregates for international users. Synchronous channel speeds are from 1.2K bps to 2.141M bps, asynchronous speeds up to 19.2K bps. Voice is supported using pulse coded modulation at 64K bps. A starting configuration, consisting of a single-chassis package with 20 voice and data ports, is priced at about $30,000.

MAY 1987

NETWORK SOFTWARE ASSOCIATES UNVEILS MODEM -- Network Software of Laguna Hills, CA introduced an auto-dialing synchronous/asynchronous modem for IBM and compatible PCs. It is called the AdaptModem 201/212, and incorporates a built-in synchronous Data Link Control adapter. AdaptModem 201/212 plugs into any full-sized PC expansion slot. In synchronous mode, it functions as a Bell 201C modem at 2,400 bps. In asynchronous mode, it functions as a Bell 212 modem at 300 or 1,200 bps. The price is $995 for the board and ACC software. NSA's synchronous communications software packages are priced separately, starting at $195.

ROCKWELL UNVEILS 9,600-BPS MODEM -- Rockwell International of Newport Beach, CA released a synchronous 9,600 bps modem, the R96MD, designed for operation over the public switched phone network through line terminations provided by data access arrangement. It meets requirements specified in CCITT V.29, V.27 ter, T.30, T.4 and T.3. The R96MD can operate at speeds of 9,600, 7,200, 4,800, 2,400 and 300 bps, and can generate voice band tones up to 4,800 Hz with a resolution of 0.15 Hz and an accuracy of 0.01 percent. The modem includes programmable tone detection and dual/single tone generation, a two-wire half-duplex, and is TTL and CMOS-compatible. The modem is designed for use in group 2 and 3 facsimile machines.

EXAR'S 2,400-BAUD SET WORKS WITH MOST MICROCONTROLLERS -- Exar Corp. employed digital signal processing technology to develop a two-chip 2,400-bit/s modem that provides all of the functions required for operation under the Bell 212A or CCITT V.22bis standards. The XR-2400 modem is designed to operate at 300, 1,200, and 2,400 bits/s. The 40-pin XR-2401 incorporates the modulation/demodulation circuitry,

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as well as such functions as carrier detection, automatic gain control, timing recovery, adaptive equalization, carrier recovery, and tone generation. The XR-2402 can be used with virtually any commercially available microcontroller, says Jim Lange, applications engineering manager. It also carries an analog-to-digital converter, a digital-to-analog converter, a band-splitting filter, a programmable-gain amplifier, asynchronous-to-synchronous and synchronous-to-asynchronous converters, and a guard-tone generator. The chips are available in plastic and ceramic pakages. The XR-2401 costs $18 each and the XR-2402 is $12 each in 10,000 unit quantities.

SIERRA'S MODEM CHIP FITS BOTH PARALLEL & SERIES INTERFACES -- Sierra Semiconductor Corp.'s 2,400-baud modem chip set gives designers flexibility that helps cut costs. Competitive chip sets use either an analog or digital signal processing solution that requires the use--and expense--of an additional microcontroller. Sierra has divided modem functions differently among the chips, allowing designers to couple an analog front-end SC11006 part with either of two microcontrollers--the SC11009 for parallel-bus interfaces or the SC11010 for RS-232-C serial transmission. Both controllers use a bit-slice core processor architecture for digital signal processing and an instruction set similar to Intel's 8096 but up to 2.3 times faster. The chips are fabricated in San Jose, CA, the company's process combining 3-um analog and 2-um digital CMOS. They were available in sample quantities in ROM-less versions that allow designers to construct their own firmware. The SC11006 costs $49 each; the SC11009 and SC11010, $40 each in 100-unit lots.

APRIL 1987

TELEBIT DESIGNS 2,400-BAUD MODEM FROM OFF-THE-SHELF PARTS -- Telebit Corp., which shook up the dial-up modem market in 1985 with its 18-Kbaud Trailblazer modem, came out with a design for a 2,400-baud modem that can be built from off-the-shelf second-sourced parts. It uses a Texas Instruments 320CM10 digital signal processor, programmed in read-only memory with basic modem functions from Telbit's Trailblazer architecture. The modem supports CCITT V,22bis, 2,400-baud transmission as well as Bell 212A and Bell 103 (1,200 and 300-baud) operation. The other two chips are an Intel Corp. 80C51 microcontoller with source code for mask programming and an Oki Semiconductor 6950B analog front end. Together the three chips cost about $27, says the Cupertino, CA company.

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The Telebit licensing fee is either a $200,000 one-time payment, which includes engineering support; or a $25,000 technology-transfer fee plus a $5/unit royalty.

MARCH 1987

ROCKWELL MODEM TRANSMITS FACSIMILE INFORMATION AT 14,400 BITS/S -- An asynchronous, half-duplex modem board from Rockwell International Corp., that handles facsimile transmissions at a 14,400-bit/s pace promises to boost throughput by 50% over existing 9,600-baud equipment operating under the CCITT V.29 facsimile standard. The R144HD can run over public phone lines as well as leased ones, according to the Irvine, CA company. The board will appeal to OEMs with applications in still-frame video telephone equipment, electronic publishing, and similar systems. In quantities of 1,000 the R144HD costs $140 each. Shipments began in April 1987.

FEBRUARY 1987

BURR-BROWN'S FIBER OPTIC MODEM EXTENDS RS-232 LINKS TO 3.5 km -- Burr-Brown Inc.'s high-speed fiber-optic modem outdistances the 50-ft limit of conventional metal cable for RS-232-C connections by a factor of about 300. The LDM80 supports 3.5-km connections and transmission rates up to 19.2-k baud. It can be used with most fiber-optic cable sizes and is completely powered by the host computer's RS-232-C port signals, eliminating the need for a separate power supply. Maximum connection length is achieved by using glass cable having a 100-um core and an attenuation of 4 dB/km. The 3.5-by-1.7-by-0.8-in. modem is small enough to mount on the back of a video display terminal. Price is $98.

JANUARY 1987

EMULEX MULTIPLEXER DOUBLES MICROVAX TERMINAL INTERFACES -- An asynchronous multiplexor from Emulux Corp. lets the Digital Equipment Corp. MicroVax II and other Q-bus systems interface with twice as many terminals as is possible with DEC's DHV11 asynchronous multiplexors--eight lines to the DHV11's four. The CS08's single-board configuration makes the increase possible by better utilizing the MicroVax's bus-interface slots, says the Costa Mesa, CA firm. The dual-width board makes possible RS-232-C connections to most existing asynchronous terminals. It costs $1,000 without modem control and $1,200 with modem control, and was to be available in mid-March 1987.

INTEL'S $35 CHIP SET HAS HAYES MODEM COMMANDS IN FIRMWARE -- Intel Corp. was offering samples of a 2,400-baud modem chip set it claimed will drop the resulting modem's retail price to less than $200. The 89024 set puts the Hayes commands in firmware and is priced at $35 in 25,000 unit quantities. It consists of the 89026 16-bit digital signal processor and the 89027 analog front end for signal filtering. For interfacing the set to IBM and compatible PCs, Intel has also come out with a universal receiver/transmitter, the 82050, which is billed as a replacement for National Semiconductor's 8250. The UART was priced at $4.50 in lots of 10,000. The modem chip set was to be in full production by the 2nd quarter of 1987, and will support the V.22bis standard. It includes a full set of RS-232-C and V.24 terminal interface signals. The MEK69024 evaluation kit--a fully functioning modem with extra area for breadboarding--is also available, for $395.

JULY 1986

ROCKWELL SHIPS SINGLE-CHIP FACSIMILE MODEM -- Rockwell International Corp.'s Semiconductor Products Division began shipping samples of a single-chip facsimile modem that transmits data over the public switched telephone network at 2,400 b/s. The R24MFX will cut the size and cost of facsimile equipment and could give a shot in the arm to the emerging market for personal FAXes. Optimized for use in compact Group 3 facsimile machines, the chip has two interfaces--a parallel microprocessor bus interface and an Rs-232-C serial port. In 1,000-piece lots, the R24MFX sells for $40 each. The Newport Beach, CA division was to begin volume shipments in August 1987.

JUNE 1986

FUJITSU U.S. ENTERS END-USER MODEM MARKET -- Fujitsu America, Inc., of San Jose, CA, in an expansion of its U.S.-based modem operations, said it will enter the end-user market for the first time and create a new modem R & D group at the firm's Palm Bay, FL facility. The first modem aimed at the non-OEM market was to be the L series, stand-alone devices in the 2,400-bps to 14.4Kbps range, said Charles W. Roedel, V.P. Data Communications. Mr Roedel indicated that they were in the process of signing up distributors, probably regionals, and that in the future Fujitsu plans to add other modem offerings to its non-OEM line. The L series is made in Japan, with some final assembly at the 50,000 square ft. Palm Bay facility where the new R & D group is being established. That group will be chartered to create core technology for modem products.

Continued......

MARCH 1986

JOINT EFFORT BY DIGITAL COMMUNICATIONS ASSOCIATES & TELEBIT PRODUCES 18 KB/S FAST DIAL-UP MODEM - A dial-up modem with instantaneous data-transmission speeds nearly twice that of existing 9.6-kb/s modems was under development between the two firms. The key to the 18-kb/s asynchronous modem, an enhanced version of a Digital Communications product dubbed Fastlink, is a design combining a multicarrier modulation scheme, digital signal processing, and new packet technologies. Along with current applications, such as microcomputer-to-mainframe links, file transfers, information-retrieval services, and electronic mail, new dial-up applications include high-resolution graphics capabilities, videotext, software distribution, and LAN gateways to public switched networks. Fastlink is also compatible with slower modems and many transmission standards, including Bell 103 for 300-b/s transmission, the CCITT V.22 and Bell 212A standards for 1.2-kb/s transmission, and the CCITT V.22 bis std. for 2.4-kb/s transmission.

JANUARY 1986

MODEM MAKES IT EASIER TO TRANSMIT DATA OVERSEAS -- A modem module from Micro Power Systems Inc. will ease international data transmission. The MP212AT not only operates in the full-duplex 300- and 1,200-bits-per-second transmission standards of the U.S., but it also supports the ITTCC V.22 A, V.22 B, and V.21 standards widely used in Europe, Japan, and other nations. The modem module is housed on a single pc board that measures 3 X 4 by 0.4 in. Samples were to be available from the Santa Clara, CA company in January 1986. In large quantities, the modem sells for $110 each.

MISCELLANEOUS 1987 MARKET DEVELOPMENTS - MODEMS & MULTIPLEXERS

Following is a 1987 chronology of market developments, including new product announcements, joint company ventures, contract awards, etc. This information is separate from the "Chronology Of New Product Introductions" section; there is no duplication of material. The name of the trade journal publishing the article, and the page number it appears on, are listed for further reference.

3/23/87 AMERICAN TELEPHONE & TELEGRAPGH IS DISTRIBUTING ITS 90 MBps DDM MULTIPLEXER THROUGH ANIXTER BROTHERS (Fiber Optics, p. 7).

3/23/87 RAPIDTECH SYSTEMS BUYS ALL RIGHTS TO POCKET MODEM PATENT FROM INVENTOR (Computerworld, p. 104).

4/11/87 AT & T JOINTLY DEVELOPS COMPACT VOICE/DATA MULTIPLEX EQUIPMENT WITH NTT (Japan Economic Jrl. p. 12).

4/13/87 M/A COM GETS CONTRACT FOR ITS 4046 MODEM FROM SATELLITE TRANSMISSION SYSTEMS (Satellite News, p. 8).

4/21/87 PRACTICAL PERIPHERALS INTRODUCES POCKET-SIZED 1200 BPS MODEM (PC Week, p. 23).

4/28/87 TELEBIT WILL LICENSE NEW 2400 BPS MODEM DESIGN, BASED ON 3 CMOS CHIPS (PC Week, p. 29).

4/29/87 DEVELCON HAS SINGLE CARD STATISTICAL MULTIPLEXER FOR ITS NETWORKING DATA PBX (Data Channels, p. 7).

5/6/87 DYNATECH HAS NEW NETWORK CONTROLLER THAT ROUTES DATA & VOICE FROM T-1 TO 2.4 Kbps LEVEL (Data Channels, p. 7).

5/11/87 PARADYNE GETS $1.5 MILLION AWARD FROM VAN WATERS & ROGERS FOR DATA COMMUNICATIONS NETWORK (Electronic Engineering Times, p. 34).

5/18/87 ADVANCED TRANSDUCER DEVICES WILL OFFER 1200 BPS HAYES-COMPATIBLE MODEM FOR IBM PS/2 AND PC LINES (Info World, p. 6).

5/25/87 IBM TO MARKET NETWORK EQUIP. TECHNOLOGIES' IDNX MULTIPLEXER (MIS Week, P. 1).

Continued..............

6/87 DATATEL UNVEILS DCP9800 T-1 NETWORK SWITCH (Satellite, p. 49).

6/8/87 NETWORK EQUIP. TECHNOLOGIES' NEW INTEGRATED DIGITAL NETWORK EXCHANGE/20 HANDLES UP TO 8 T-1 CIRCUITS (MIS Week, p. 25).

6/9/87 DATA RACE WILL EXCHANGE HIGH-SPEED MODEM TECHNOLOGY WITH U.S. ROBOTICS (PC Week, p. C3).

6/15/87 PARADYNE IS OEMing SPECTRUM DIGITAL'S 3230 T-1 MULTIPLEXER (MIS Week, p. 31).

MODEMS PRODUCT LINE COMPARISON, BY COMPANY (APPLICATIONS, FEATURES, TECHNOLOGIES)

The following is a summary and comparison of some of the more well-known modem product lines by major manufacturers in the market. It is by no means an all-inclusive listing, but will give the reader a good understanding of the most common capabilities, applications, features and technical aspects related to modems.

CODEX 2260

The Codex 2260 supports full-duplex 9600 bps operation and falls back to 4800 bps. The modem has several features consistent with its orientation toward large-scale data communications applications: a leased-line phone connection jack, an internal phone book that stores up to nine telephone numbers, password protection, and line-quality monitoring capabilities via an externally connected oscilloscope. Like the Racal modem, the Codex 2260 has a drop-down front panel that conceals a five-key keypad. The Codex modem supports th Hayes AT command set as well as its own Codex Verbose command set.

FASTCOMM 2496

The Fastcomm 2496 is an asynchronous half-duplex 9600 bps modem capable of communicating at 300, 1200, or 2400 bps as well as using a proprietary adaptation of V.29. It has an error correction technique, a hardware-based CRC-16 implementation that uses selective retransmission. It can switch a remote modem to the highest mutually acceptable data rate. However, it is one of the few modems that does not have a jack for attaching the telephone to the modem, allowing for voice calls to be received when the modem is not in operation.

HAYES SMARTMODEM 2400

The Smartmodem series sets the standard among intelligent modems. It supports 300 and 1200 bps predecessors. It has several commands such as for controlling speaker volume, and the selection of synchronous and asynchronous modes. In the future, Hayes will use a version of the CCITT X.25 packet-switching protocol to provide error correction at 2400 bps.

MICROCOM AX/9624c

The Microcom AX/9624c is a 9600 bps modified V.29 modem that can also operate at 2400, 1200, and 300 bps. It incorporates MNP class 5, a data compression algorithm currently available only on Microcom modems. Effective throughput can be dramatically increased, to an average of 14,000 bps. The Microcom modem is limited to half-duplex operation at high speed, and there is no on/off switch. It uses a proprietary SX command set as well as the Hayes AT complement.

MIGENT POCKET MODEM

The Migent 1200 bps modem is either battery or AC-powered, and is about the size and weight of a TV remote control, making it very convenient. It is Hayes compatible and has no hardware switches to set or configuration routines to run. Configuration settings and one phone number and access code can be stored in nonvolatile memory. Error correction is accomplished via the communications software. It is priced at $249, very economical and appropriate if you don't anticipate making large-volume data transfers and can get by with 1200 bps.

NOVATION PROFESSIONAL 2400

The Novation 2400 is a 2400 bps Hayes-compatible modem with advantages in the options available: versions that include MNP error correction and password and callback security features. Novation also has LCD displays, and the modem, when turned on, will automatically perform a six-step self-test with audible musical feedback.

RACAL-VADIC 9600 VP

Racal's 9600 bps modem uses a proprietary techniques to adapt V.29 technology. The dynamic duplex protocol allows full-duplex operation when interactive asynchronous data is being transmitted, and switches to a half-duplex link for high speed transfers. The front panel features a nine-LED status indicator panel, along with a ten-key keypad from which commands (such as phone numbers for dialing) can be entered. Modem commands can be issued using either the Vadic or Hayes AT command set. As with the Microcom modem, there is no on/off switch: the modem must be unplugged to be turned off. Error correction is provided using a superset of MNP class 3. In addition, the modem automatically adjusts transmission speed to balance error rates and data throughput. When errors occur the modem falls back from 9600 bps to 4800, 2400, or 1200 bps, until the lowest error rate is achieved.

TELCOR ACCELERATOR

The Telcor (formerly Telebyte) Accelerator is a full-duplex 2400-baud modem that achieves 9600 bps using a data compression technique. Throughput varies from 6500-9600 bps. Telcor's error correction scheme is a proprietary implementation of a CRC-16 protocol, with the firm planning to release a version that incorporates MNP class 3. Telcor's acceleration can be turned off so that the modem also supports communication at 300 and 1200 bps.

TELEBIT TRAILBLAZER

This modem can transmit and receive data asynchronously at speeds up to 18,000 bps, using a proprietary transmission and error-correcting protocol appropriately named PEP (Packetized Ensemble Protocol). The Trailblazer is also compatible with 300, 1200, and 2400 bps modems and will automatically shift to match the transmission speed of the remote modem during the initial "handshake". Trailblazer can transfer data using Microcom's MNP protocol. Telebit has also added the Kermit and Xmodem protocols. Like the Racal modem, Telebit uses an adaptive duplex technique. It is Hayes compatible, and a CRC-16 protocol with selective transmission is used to ensure that data is received error-free.

COMPETITOR LISTS - MODEMS & MULTIPLEXORS

The following section lists the major manufacturers/suppliers of various types of modems and multiplexors, compiled from a recent issue of the Electronic Design Gold Book and Thomas Register. From the Gold Book, Marketdata has identified at least 100 modem makers, and an additional 89 producers of multiplexors--for a combined total of at least 189 manufacturers competing for modem & multiplexor sales. A significant number of modem makers (27%--33 of 122 companies listed) **also** make multiplexors--no surprise, since the two products are closely related and part of the overall "data communications" market.

The company's name and address are provided in this section, with an additional product key that identifies **what type** of modem or multiplexor the company makes. **Modems** can be classified as follows..............

- Acoustically Coupled
- Asynchronous
- Digital
- Fiber Optic
- Frequency Shift Keyed
- Integrated Circuit
- Limited Distance
- Long Haul
- Short Haul
- Synchronous
- Voice Grade

Multiplexors can be classified as.....................

- Analog
- Concentrator
- Digital
- Frequency Division
- Low-Level
- Microwave
- Radio
- Time Division
- Transmission
- Video
- Wireline

MODEM MANUFACTURERS

KEY:
A = NOT LISTED ELSEWHERE
B = ACCOUSTICALLY COUPLED
C = ASYNCHRONOUS
D = FREQUENCY SHIFT KEYED
E = SYNCHRONOUS

Advanced Micro Devices Inc.
901 Thompson Place MS 145, Sunnyvale, CA 94088 (D)
Amdahl Corporation
Coms Systems 2500 Walnut Avenue, Marina del Rey, CA 90291 (A)
Artel Coms. Corp.
Box 100 West Side Station, Worcester, MA 01602 (E)
Astocom Corporation
120 W. Plato Blvd., St. Paul, MN 55107 (A)
Aydin Microwave
75 E. Trimble Road, San Jose, CA 95131 (D)
Aydin Monitor Systems
Aydin Corporation 502 Office Center Drive, Ft. Washington, PA 19034 (D)
BO-Sherrel Co., Inc.
36133 Niles Blvd., Freemont, CA 94536 (A)
Betatronics Inc.
9323 Lincolnwood Avenue, Evanston, IL 60203 (A)
Bizcomp Corporation
632 Mercury Drive, Sunnyvale, CA 94086 (A)
CTS Knights
CTS Electronic Product Group 400 Reimann Avenue, Sandwich, IL 60548 (D)
Cermetek Microelectronics
1308 Borregas Avenue, Sunnyvale, CA 94086 (A)
Cetec Vega
9900 Baldwin Place, El Monte, CA 91731 (A)
Codenoll Technology Corp.
1086 N. Broadway, Yonkers, NY 10701 (E)
Codex Corp
20 Cabot Blvd., Mansfield, MA 02048 (A)
Coherent Coms. Systems Corp.
60 Commerce Drive, Hauppauge, NY 11788 (C)
ComData Corp.
7900 N. Nagle Avenue, Morton Grove, IL 60053 (A)
ComDesign Inc.
751 S. Kellogg Avenue, Goleta, CA 93117 (C)
Complexx Systems Inc.
4930 Research Drive, Huntsville, AL 35805 (E)
Computrol
Kidde Automated Systems Inc. 15 Ethan Allen Hwy., Ridgefield, CT 06877 (A)
Comtech Data Corp.
350 N. Hayden Road, Scottsdale, AZ 85257 (A)
Concord Data Systems
303 Bear Hill Road, Waltham, MA 02154 (A)
Coosol Inc.
Computer Baron 3013 Harbor Blvd., Costa Mesa, CA 92626 (C)

MODEM MANUFACTURERS

Da-Tel Research Co., Inc.
PO Box 1206, Montrose, CO 81402 (A)
Dantel Inc.
2991 N. Argyle Avenue, Fresno, CA 93727 (D)
Data Rental/Sales Inc.
8611 Hayden Place, Culver City, CA 90230 (A)
Data-Control Systems
Div. of Quanta Systems 1455 Research Blvd., Rockville, MD 20850 (A-E)
Datacom Northwest Inc.
S. Complex Building 100 3003 112th Street, S.W., Everett, WA 98204 (C)
Datagram Corp.
11 Main Street, E. Greenwich, RI 02818 (A)
Dataprobe Inc.
110 W. Palisades Blvd., Palisades Park, NJ 07650 (D)
Datec Inc.
200 Eastowne Drive, Ste. 116, Chapel Hill, NC 27514 (A)
Decom Systems Inc.
340 Rancheros Drive, San Marcos, CA 92069 (A)
Digital Matrix Corp.
105 Filley Street, Bloomfield, CT 06002 (B)
Dynamic Measurements Corp.
8 Lowell Avenue, Winchester, MA 01890 (C)
Dynatech Corp.
Dynatech Data Systems 7644 Dynatech Ct., Springfield, VA 22153 (E)
Electronics Warehouse Inc.
Box 624, Old Lyme, CT 06371 (A)
Entpr. Sys. Corp.
Box 698, Dover, NH 03820 (D)
Exar Integrated Systems, Inc.
750 Palomar Avenue PO Box 3575, Sunnyvale, CA 94088 (A)
FG Engineering Co.
Box 476 Highway 89A, Fredonia, AZ 86022 (A)
Fibronics Intl. Inc.
325 Stevens Street, Hyannis, MA 02601 (A)
GTE Corporation
GTE Sys. Coms. Sys. Division 77 A Street, Needham Heights, MA 02194 (A)
Gandalf Data Inc.
1019 S. Noel, Wheeling, IL 60090 (A)
Genelex Inc.
64 Gough Avenue, Ivyland, PA 18974 (A)
General Data Com. Ind. Inc.
One Kennedy Avenue, Danbury, CT 06810 (A)
HAL Coms. Corp.
PO Box 365, Urbana, IL 91801 (D)
Halcyon
2121 Zanker Road, San Jose, CA 95131 (E)
Harris Corp.
RF Coms. Group 1680 University Avenue, Rochester, NY 14610 (D)
Harvey Hubbell Inc.
Pulsecom Div. 2900 Towerview Road, Herndon, VA 22071 (D)
Hayes Microcomputer Products Inc.
5923 Peachtree Indl. Blvd., Norcross, GA 30092 (A)

MODEM MANUFACTURERS

Hughes Aircraft Co.
Corporate Marketing PO Box 1053, El Segundo, CA 90245 (A)
Hycom Inc.
16841 Armstrong Avenue, Irvine, CA 92714 (A)
Infotron Systems Corp.
9 N. Olney Avenue, Cherry Hill, NJ 08003 (A)
Inmac
2465 Augustine Drive, Santa Clara, CA 95051 (B)
International Data Sciences Inc.
7 Wellington Road, Lincoln, RI 02865 (A)
Intertel Inc.
6 Shattuck Road, Andover, MA 01810 (A)
Kinex Corp.,
Nokia Inc. 6950 Bryan Dairy Road, Largo, FL 33543 (A)
Leaming Inds.
180 McCormick Avenue, Costa Mesa, CA 92626 (A)
M/A-COM DCC Inc.
11717 Exploration Lane, Germantown, MD 20874 (A)
MICOM Systems Inc.
20151 Nordhoff Street, Chatsworth, CA 91311 (A)
Madzar Corp.
37490 Glenmoor Drive, Fremont, CA 94536 (A)
Manage Inc., Electro-Optics
PO Box 175 40 Nichols Road, Chicopee, MA 01014 (A)
Micro-Baud Systems Inc.
3393 De La Cruz Blvd., Santa Clara, CA 95050 (A)
Micro-Link Corp
14602 North U.S. Hwy 31, Carmel, IN 46060 (A)
Misco Inc.
Somputer Supplies One Misco Plaza, Holmdel, NJ 07733 (B)
Morrow
600 McCormick Street, San Leandro, CA 94577 (A)
Multi-Tech Systems Inc.
82 Second Avenue, S.E., New Brighton, MN 55112 (A)
NCR Omten Inc.
NCR Corporation 2700 Snelling Avenue N., St. Paul, MN 55113 (E)
NU Data Corp.
32 Fairview Avenue, Little Silver, NJ 07739 (D)
Novation Inc.
20409 Prairie Street, Chatsworth, CA 91311 (A)
Optical Data Systems
1226 Exhange Drive, Richardson, TX 75081 (C)
Penril DataComm
Div. of Penril Corp. 207 Perry Pkwy., Gaithersburg, MD 20877 (A)
Perkins Research & Mfg. Co.
Canoga Data Systems 21218 Vanowen Street, Canoga Park, CA 91303 (E)
Plantronics/Frederick Elecs. Corp.
7630 Hayward Road, Frederick, MD 21701 (D)
Prentice Corp.
266 Caspian Drive PO 3544, Sunnyvale, CA 94088 (A)
RFL Ind. Inc.
Coms. Div. Powerville Road, Boonton, NJ 07005 (D)

MODEM MANUFACTURERS

Racal-Vadic
    1525 McCarthy Blvd., Milpitas, CA 95035 (A)
Raven Electronics Corp.
    400 Wolverine Way, Sparks, NV 89431 (C)
Rockwell Intl Corp.
    Commercial Elecs. Ops. 1200 N. Alma Road, Richardson, TX 75081 (D)
SCI Systems Inc.
    8600 S. Memorial Parkway PO Box 4000, Huntsville, AL 35802 (D)
Seaboard Electronics Co.
    Seaboard Inds. Inc. 70 Church Street, New Rochelle, NY 10805 (D)
Shaffstall Corp., Penta Systems International
    7901 E. 88th Street, PO 50990, Indianapolis, IN 46250 (C)
Signatron Inc.
    Dept. M 12 Hartwell Avenue, Lexington, MA 02173 (A)
Sonex Corp.
    931-939 E. Lycoming Street, Philadelphia, PA 19124 (D)
TM Systems Inc.
    25 Allen Street, Bridgeport, CT 06604 (A)
Tech Magic Inc.
    17742 Mitchell, N. Irvine, CA 92714 (C)
Tele-Signal Corp.
    185 Oser Avenue, Hauppauge, NY 11788 (D)
Telebyte Tech Inc.
    148 New York Avenue, Halesite, NY 11743 (A)
Telecom Terminal Systems
    621 Hindry Avenue, Inglewood, CA 90301 (D)
Teleprinter Corp.
    550 Springfield Avenue, Berkeley Heights, NJ 07922 (A)
Teltone Corp.
    Telcom Components 10801 120th Avenue, N.E., Kirkland, WA 98033 (A)
Terminal Data Corp.
    15733 Crabbs Branch Way, Rockville, MD 20855 (C)
Time Zero Corp.
    103 Central Avenue, Clifton, NJ 07011 (A)
Timeplex Inc.
    400 Chestnut Ridge Road, Woodcliff Lake, NJ 07675 (D)
Tuck Data Coms. Inc.
    Tuck Elecs. Inc. 330 Second Street, New Cumberland, PA 17070 (A)
US Robotics Inc.
    1123 W. Washington Blvd., Chicago, IL 60607 (A)
Ungermann-Bass Inc.
    2560 Mission College Blvd., Santa Clara, CA 95050 (E)
Universal Data Systems, Inc.
    Motorola Inc. 5000 Bradford Drive, Huntsville, AL 35805 (A)
Ven-Tel Inc.
    2342 Walsh Avenue, Santa Clara, CA 95051 (C)
Zeta Labs Inc.
    3265 Scott Blvd., Santa Clara, CA 95051 (A)
Zoom Telephonics
    207 South Street, Boston, MA 02111 (D)

MULTIPLEXER MANUFACTURERS

KEY:
1 = ANALOG
2 = DIGITAL
3 = FREQUENCY DIVISION
4 = LOW-LEVEL
5 = MICROWAVE
6 = RADIO
7 = TIME DIVISION
8 = TRANSMISSION
9 = VIDEO
10 = WIRELINE CONCENTRATORS

AD Data Systems Inc.
200 Commerce Drive, Rochester, NY 14623 (1)
AUL Instruments Inc.
1055 Stewart Avenue, Garden City, NY 11530 (1)
Acromag Inc.
30765 Wixom Road, Wixom, MI 48096 (1)
Action Instruments Co., Inc.
8601 Aero Drive, San Diego, CA 92123 (1)
Advanced System Concepts
435 Lake Avenue, Pasadena, CA 91101 (2)
Amecom Div.
Litton Systems Inc. 5115 Calvert Road, College Park, MD 20740 (6)
Analog Devices Inc.
2 Technology Way, Norwood, MA 02062 (1)
Analog Precision Inc.
1620 N. Park Avenue, Tucson, AZ 85719 (1)
Analogic Corp.
Data Conversion Div. Audubon Road, Wakefield, MA 01880 (1)
Analogic Corp.
Industrial Technology 14 Electronics Avenue, Danvers, MA 01923 (1)
Anaren Microwave Inc.
PO Box 178 6635 Kirkville Road, E. Syracuse, NY 13057 (5)
Applied Research Inc.
160 Dupont Street, Plainview, NY 11803 (3)
Aydin Monitor Systems
Aydin Corporation 502 Office Center Drive, Ft. Washington, PA 19034 (1)
Aydin Vector Div.
PO Box 328, Newtown, PA 18940 (1)
Belden Electric Wire & Cable
PO Box 1980, Richmond, IN 47374 (2)
Buhl Optical Co.
1009 Beech Avenue, Pittsburgh, PA 15233 (9)
Burr-Brown Corp.
PO Box 11400, Tucson, AZ 85734 (1)
Cardion Electronics
Coms. Dept. 895 Waverly Avenue, Holtsville, NY 11742 (1)
Catel Telecommunications
4800 Patrick Henry Drive, Santa Clara, CA 95054 (6)
Cetec Vega
9900 Baldwin Place, El Monte, CA 91731 (4)
Cincinnati Electrosystems Inc.
469 Wards Corner Road, Loveland, OH 45140 (2)
Cirqtel Inc.
10504 Wheatley Street, Kensington, MD 20895 (5)

MULTIPLEXER MANUFACTURERS

Coastcoem
2312 Stanwell Drive, Concord, CA 94520 (1)
Colorado Data Systems Inc.
3301 W. Hampden Avenue, Englewood, CO 80110 (1)
Colorado Video Inc.
PO Box 928, Boulder, CO 80306 (9)
Control Module Inc.
380 Enfield St., Enfield, CT 06082 (2)
Cutler-Hammer Products
Eaton Corporation 4201 N. 27th St., Milwaukee, WI 53216 (1)
Cytec Corp
107 N. Washington Street, E. Rochester, NY 14445 (1)
Data Translation Inc.
100 Locke Drive, Marlboro, MA 01752 (1)
Data-Control Systems
Div. of Quanta Systems 1455 Research Blvd., Rockville, MD 20850 (1)
Datacap Inc.
11558 Sorrento Valley Road Building #5, San Diego, CA 92121 (2)
Datawest Corp
7333 E. Helm Drive, Scottsdale, AZ 85260 (1)
Data General Corp.
4400 Computer Drive, Westboro, MA 01580 (2)
Decom Systems Inc.
340 Rancheros Drive, San Marcos, CA 92069 (2)
Delta Microwave Inc.
840 Via Alondra, Camarillo, CA 93010 (5)
Dielectric Coms.
Tower Road, Raymond, ME 04071 (8)
Dynamic Sales of New England
97 Cambridge Street, Burlington, MA 01803 (1)
Dynamics
Div. of Waugh Controls 9001 Fullbright Avenue, Chatsworth, CA 91311 (1)
E&L Instruments
Interplex Electronics Co. 70 Fulton Terrace, Box 1942, New Haven, CT 06509 (1)
E-Systems Inc.
Corporate Headquarters PO Box 226030, Dallas, TX 75266 (2)
Electromatic Comp. Ltd.
1531 Burgundy Parkway, Streamwood, IL 60103 (10)
Electronics Warehouse Inc.
Box 624, Old Lyme, CT 06371 (2)
Emerson Electric Co.
Doric Scientific Div. 3883 Ruffin Road, San Diego, CA 92123 (2)
Fairchild Camera & Instrument Corp.
Digital Prods. Div. 333 Western Avenue S., Portland, ME 04106 (2)
Fairchild Weston Systems Inc.
Data Systems (EMR) PO Box 3041, Sarasota, FL 33578 (1)
Fibronics International Inc.
325 Stevens Street, Hyannis, MA 02601 (2)
Futronix Inc.
PO Box 2269, Sunnyvale, CA 94087 (2)
GE Datel
11 Cabot Blvd., Mansfield, MA 02048 (1)

MULTIPLEXER MANUFACTURERS

GEN/COMP Inc.
    6 Algonquin Road, Canton, MA 02021 (7)
Gamma-F Corp.
    3111 Fujita Street, Torrance, CA 90505 (5)
Global Specialties, Interplex Electronics Inc.
    70 Fulton Terrace, PO Box 1942, New Haven, CT 06509 (1)
HERCO
    PO Box 3246, Houston, TX 77001 (1)
Hughes Aircraft Co.
    Corporate Marketing PO Box 1053, El Segundo, CA 90245 (1)
Hybrid Systems Corporation
    Marketing 22 Linnell Circle, Billerica, MA 01821 (1)
IPAC Group Inc.
    3047 Industiral Blvd., Bethel Park, PA 15102 (1)
Information Transfer Indl. Inc.
    PO Box 357, Holcomb, NY 14469 (1)
Infotron Systems Corp.
    9 N. Olney Avenue, Cherry Hill, NJ 08003 (1)
Intech Inc.
    Microcircuits 2270 Martin Avenue, Santa Clara, CA 95050 (1)
Interface Engineering Inc.
    386 Lindelof Avenue, Stoughton, MA 02072 (1)
Intermec Corp.
    PO Box 360602, Lynnwood, WA 98046 (2)
Javelin Electronics Inc.
    19831 Magellan Drive, Torrance, CA 90502 (9)
K & L Microwave Inc.
    408 Coles Circle, Salisbury, MD 21801 (3)
KW Engineering Inc.
    4565 Ruffner Street, San Diego, CA 92111 (5)
Karkar Electronics Inc.
    245 11 Street, San Francisco, CA 94103 (2)
Keithley Instruments Inc.
    28775 Aurora Road, Cleveland, OH 44139 (1)
Kinetic Systems Corp.
    11 Maryknoll Drive, Lockport, IL 60441 (1)
LDV Electro Science Ind. Inc.
    2027 Teall Avenue, Syracuse, NY 13206 (5)
Lark Engineering Co. Inc.
    26401 Calle Rolando, San Juan Capistrano, CA 92675 (5)
Larse Corp.
    4600 Patrick Henry Drive, Santa Clara, CA 95050 (2)
Leaming Industires
    180 McCormick Avenue, Costa Mesa, CA 92626 (1)
Lightwave Coms. Inc.
    650 Danbury Road, Ridgefield, CT 06877 (1)
Loral Terracom
    Loral Corp. 9020 Balboa Avenue, San Diego, CA 92123 (2)
Lorch Electronics Corp.
    105 Cedar Lane, Englewood, NJ 07631 (5)
Magnum Microwave Corp.
    365 Ravendale Drive, Mountain View, CA 94043 (2)
Manage Inc.
    Electro-Optics PO Box 175, 40 Nichols Rd., Chicopee, MA 01014 (7)

MULTIPLEXER MANUFACTURERS

Marlee Switch Co.
933-D N. Central Avenue, Upland, CA 91786 (5)
Matrix Corp.
2260 Distributors Drive, Indianapolis, IN 46241 (2)
McDonnell Douglas Electronics
Box 426, St. Charles, MO 63302 (2)
Megadata Corp.
35 Orville Drive, Bohemia, NY 11716 (8)
Mepcom International Inc.
PO Box 610719, Dallas, TX 75261 (2)
Micro Coms Inc.
438 Kelley Avenue PO Box 4365, Manchester, NH 03108 (5)
Microphase Corp.
587 Connecticut Avenue, Norwalk, CT 06880 (5)
Moseley Assocs. Inc.
111 Castilian Drive, Goleta, CA 93117 (8)
Motorola Coms. & Elecs. Inc.
1301 E. Algonquin Road, Schaumburg, IL 60196 (5)
Mu-Del Electronics Inc.
2426 Linden Lane, Silver Spring, MD 20910 (5)
Narda Microwave Corp.
435 Moreland Road, Hauppauge, NY 11788 (5)
National Semiconductor Corp.
2900 Semiconductor Drive, Santa Clara, CA 95051 (1)
North Hills Electronics Inc.
Alexander Place, Glen Cove, NY 11542 (3)
Omega Engineering Inc.
1 Omega Drive, Stamford, CT 06907 (1)
Opto 22
15461 Springdale Street, Huntington Beach, CA 92649 (1)
P & H Labs
4496 Runway Street PO Box 1800, Simi Valley, CA 93062 (5)
Phoenix Data Inc.
3384 W. Osborn Road, Phoenix, AZ 85017 (1)
Point 4 Data Corp.
2569 McCabe Way, Irvine, CA 92714 (10)
Precision Digital Corp.
80 Coolidge Hill Road, Watertown, MA 02172 (1)
Premier Microwave Corp.
33 New Broad Street, Port Chester, NY 10573 (5)
Preston Scientific
805 E. Cerritos Avenue, Anaheim, CA 92805 (1)
RYT Ind. Inc.
336 Mathew Street, Santa Clara, CA 95050 (5)
Rochester Instrument Systems Inc.
255 N. Union Street, Rochester, NY 14605 (1)
Ronan Engineering Co.
21200 Oxnard Street, Woodland Hills, CA 91367 (2)
SCI Systems Inc.
8600 S. Memorial Pkwy PO Box 4000, Huntsville, AL 35802 (1)
Sage Labs Inc.
3 Huron Drive, Natick, MA 01760 (5)
Scanivalve Corp.
PO Box 20005, San Diego, CA 92120 (1)

MULTIPLEXER MANUFACTURERS

Scientific Coms Inc.
    2908 National Drive, Garland, TX 75041 (5)
Seiscor Technologies
    5311 S. 122 E. Avenue PO Box 470580, Tulsa, OK 74147 (1)
Sercel Inc.
    17155 Park Row PO Box 218909, Houston, TX 77218 (8)
Serial Lab Prods. Inc.
    162 Cook Lane PO Box 766, Marlboro, MA 01752 (1)
Signetics Corp.
    U.S. Philips Corp. 811 E. Arques Avenue, PO Box 3409, Sunnyvale, CA 94088 (2)
Siliconix Inc.
    2201 Laurelwood Road, Santa Clara, CA 95054 (1)
Singer Co.
    Kearfott Div. 1150 McBride Avenue, Little Falls, NJ 07424 (2)
Solid State Electronics
    18646 Parthenia Street, Northridge, CA 91324 (8)
Sonex Corp.
    931-939 E. Lycoming Street, Philadelphia, PA 19124 (1)
Sprengnether Instruments
    Dyneer Corp. 4150 LaClede Avenue, St. Louis, MO 63108 (1)
Standard Engineering
    44800 Industrial Drive Dept. O, Fremont, CA 94538 (1)
Tau-Tron Inc.
    Unit of General Signal 10 Lyberty Way, Westford, MA 01886 (2)
Tech Research & Mfg. Inc.
    Grenier Field RFD #10, Manchester, NH 03103 (5)
Teledyne Crystalonics
    147 Sherman Street, Cambridge, MA 02140 (2)
Telonic/Berkeley Inc.
    2925 Laguna Canyon Road PO Box 277, Laguna Beach, CA 92652 (5)
Tennelec Inc.
    601 Oak Ridge Tpke., Oak Ridge, TN 37830 (1)
Texas Instruments Inc.
    Semiconductor Group PO Box 225012 M/S 57, Dallas, TX 75265 (2)
Transmagnetics Inc.
    210 Adams Blvd., Farmingdale, NY 11735 (1)
Transmation Inc.
    PO Box 7803, Rochester, NY 14606 (1)
Universal Data Systems
    5000 Bradford Drive, Huntsville, AL 35805 (1)
Wavecom
    Loral Corp. 9036 Winnetka Avenue, Northridge, CA 91324 (5)
West Coast Research Corp.
    Transducer Technology Specs. PO Box 25061, Los Angeles, CA 90025 (1)
Zeltex Inc.
    940 Detroit Avenue, Concord, CA 94518 (1)

Smartmodem 2400--combines high data transmission rates with ease of use and flexibility, communicates in traditional asynchronous personal computer environment and the synchronous mainframe environment. Hayes AutoSync enables it to place a call from an asynchronous terminal, then switch to synchronous communication. Optional sppeds: 2400, 1200, 300 bps.

Smartmodem 2400B--capability to communicate synchronously to a mainframe or value-added network through a standard personal computer communications port.

V-Series Smartmodem 9600, 9600 B--can send and receive data across dial-up or conditioned leased lines at 9600 bps and achieves up to 19,200 bps throughput with adaptive compression. Fast turnaround "ping-pong" operation, error-control, forward error-correction. Used for IBM AT or 100% compatible PCs.

V-Series Smartmodem 2400, 2400B--in addition to functions of regular 2400, also provides error-control, increased throughput with adaptive compression, can achieve up to 4800 bps effective throughput. Can be used with IBM PC, XT, AT or 100% compatible.

V-Series Modem Enhancer--an external unit that resides between your PC and Hayes Smartmodem 2400 or 1200, adds V-series features to regular Hayes modems.

Transnet 1000-provides both print buffering and an electronic mailbox in one device, available with 128K or 512K RAM. A standalone modem, printer, and Transnet 1000 can operate without being connected to a computer and can serve as a mailbox.

Smartcom I, II communications software--for Apple II, Macintosh computers, Smartcom II Version 3.0--for IBM PC and compatibles, and IBM Token Ring PC network.

PARADYNE CORP.

Paradyne designs, manufactures, sells and services data communications equipment and systems which primarily facilitate the rapid transmission of data between computers, via telephone lines. Contributions to total revenues by main business segments for recent years were as follows........

	1985	1984	1983	1982
Equipment Sales	72 %	79 %	77 %	82 %
Maintenance/lease revenues	28	21	23	18

Foreign sales accounted for about 16% of sales during 1985, compared to 13% the prior year.

The company's main product lines include the following.........Medium and high-speed modems-- designed for the transmission and reception of data mainly from 1,200 to 19,200 bps, available in diagnostic and nondiagnostic configurations, Network Management Sysytems--the firm's **ANALYSIS** network diagnostic and management system monitors, analyzes, and reports critical network performance information in order to expedite the detection and correction of problems to restore the network to operation, and **PIX** (parallel interface extenders) communications systems--designed to improve efficiency for remote users of IBM computers.

Its line of modems includes...........the Challenger, Fox, LSI, MP, MPX, MPX 4800, MPX 9600, and VHS series, and the T96 and HDX 9600, as well as fiber-optic devices.

A major development in March, 1987 was that fraud charges against Paradyne and eight of its officers were settled when the firm pleaded guilty to conspiracy, agreed to pay $1.2 million in fines and costs, and removed Robert Wiggins as chairman and president. All other charges against Paradyne in Tampa, Florida federal court were dropped, as were all charges against four of the defendants. Charges against Mr. Wiggins and three others were deferred under a pre-trial diversion program, and were to be dropped after one year upon successful completion of the program. The Federal government agreed to dismiss its civil false-claims suit against the company and lift its suspension of the firm as a Federal contractor. Paradyne also agreed to settle related derivative and shareholder suits by paying about $8.1 million.

All of these legal woes have taken its toll on the company. According to an April 6, 1987 article by Business Week, the company still remains among the top five suppliers in the modems market, but it has slipped to number two in the $120 million market for high-speed devices, ceding the number one spot to Codex Corp. (Motorola subsidiary) and Racal-Milgo. Paradyne is no longer the leader in technology, market share, or price.

The company's new chief executive is Jerry T. Kendall, a 43 year old executive whose background is primarily in marketing. He has had to struggle with rebuilding the company's morale, product strategy, and recent heavy losses. Kendall is easing out of computers to concentrate on

Continued..............

modems again, and faces challenges to get into the fast-growing T-1 multiplexor market that Codex is taking advantage of. Progress has been made. Over the past two years he has revamped accounts receivable and billings systems, written down $20.6 million in inventory, cut the workforce 20% to 3,400, and reduced debt from $137.6 million in 1985 to $93 million, resulting in a positive cash flow. Kendall hopes to introduce Paradyne's version of a T-1 multiplexor sometime this year.

According to Value Line, revenues for 1986 (preliminary) rose 3.4% year-to-year, limited by continuing softness in the electronics industry. Despite the capitalization of software development costs and ongoing efforts to reduce expenses, a $9 million 1986 provision for legal and/or settlement costs led to a pre-tax loss of $37.6 million. Following is an analysis of Paradyne's financial position since 1980..........

	Sales ($ Million)	Net Income ($ Million)	Net As % Sales	Capital Expend. ($ Mill.)	Current Ratio	Return On Assets
1980	$76	$8.3	10.9	$21.9	3.9	12.6
1981	135	17.5	12.9	46.6	2.5	12.9
1982	207	26.9*	13.0	60.3	4.2	12.4
1983	209	3.7	1.7	31.7	4.2	1.4
1984	290	11.0	3.8	53.3	4.3	3.5
1985	253	(31.2)	NM	45.1	6.1	NM

NM-Not meaningful * Reflects accounting change

As of August 26, 1987, a unit of Saul Steinberg's Reliance Group Holdings Inc. said it holds a 7.4% stake in Paradyne, purchased for investment purposes. The group said it holds 1,690,400 shares of Paradyne common, including 1,435,800 purchased from August 14-17 for $8 to $8.25 a share.

Paradyne said it has about 22.9 million common shares outstanding on a fully diluted basis. The Wall Street Journal reported that Mr. Steinberg, a New York investor who is chairman and chief executive officer of the two Reliance companies, may eventually attempt a takeover.

RACAL ELECTRONICS PLC

Racal Electronics is the world's largest data communications company, 30 years old, based in Britain, and having 1987 sales in excess of $2 billion.

Continued..........

The company offers a broad product line, ranging from simple modems for PCs, multiplexers and LANs, through to powerful packet switching systems, with network management to oversee the entire installation.

Following is a breakdown of Racal's major business areas, and geographic analysis of sales, for 1986 and 1987...........(percent of total sales in parentheses)

	1987	1986
TOTAL SALES ($ 000)	$2,065,355	$2,026,130
Security	632,184 (30.6%)	570,014 (28.1)
Data Communications	445,401 (21.6)	433,970 (21.4)
Radio Communications	210,379 (10.2)	294,957 (14.6)
Defense Radar & Avionics	203,061 (9.8)	210,215 (10.4)
Marine & Energy	176,315 (8.5)	210,947 (10.4)
Telecommunications	109,930 (5.3)	55,301 (2.7)
Specialized Businesses	288,085 (13.9)	250,726 (12.4)

GEOGRAPHIC ANALYSIS OF SALES

	1987	1986
Africa	5 %	5 %
The Americas	23	25
Asia & Australasia	15	17
United Kingdom	40	39
Europe (exc. U.K.)	17	14

Racal's Data Communications division's principal activities/products include............corporate data networks, data communications equipment/systems, data encryption devices, voice & data digital communications products, local area communications, network management, image processing systems, and turnkey data networks.

Continued.............

The firm maintains over 280 parts and customer support centers in North America. As evidence of its expanding product line and movement into the fast-growing LAN market, its **PLANET** system has been installed in organizations as diverse as the U.S. Navy and Colonial Penn Insurance Co.

Racal operates two data communications companies in the U.S.--Racal-Milgo (Sunrise, FL) and Racal-Vadic (Milpitas, CA). The company reports that the data communications group had an excellent year, improving profits from 15,054,000 (British pounds) to 44,076,000 from 1986 to 1987. It was the largest contributor to Racal's operating profits, and is expected to remain so this year.

Racal-Milgo increased both sales and profits, and is investing heavily in the next generation called **SUNRISE,** giving it technology needed to win large systems contracts. Further orders for this type of business include one from American Airlines for their SABRE seat reservation system and a contract for $11 million from the Social Security Administration for a national data network. Racal-Milgo (UK) continued its good performance, with orders from the Is Bank in Turkey, Hertz vehicle rentals and AP Dow Jones Telerate network. The company has embarked on a program of strategic acquisitions, joint ventures, and formation of new subsidiaries.

Racal-Vadic had a 10% sales increase, and returned to profitability. In the U.S. market, it is addressing demands for higher speed data transmission over public phones lines, and internationally a new product range will maintain the company's leading supplier position in low-medium speed dial-up modems. IBM has asked the firm to develop and produce modems for their CONVERTIBLE PC and new range of PCs. Other major orders were received from Mastercard International and the Johnson Space Center in Houston.

Early in 1986, Racal-Vadic shipped its two millionth modem. The company began in 1969 as Vadic, in Los Altos Hills, CA. In 1978, Racal Electronics of Britain bought Vadic, creating the world's largest modem company. Racal-Milgo and Racal-Vadic together serve customers in 120 countries and produced 1986 revenues approaching $500 million. Each company operates autonomously. Racal Vadic operates 11 regional sales offices (San Francisco, LA, Denver, Dallas, Chicago, St. Louis, NY, Boston, Washington, DC, Hartford, Philadelphia).

Vadic's major product lines include...........Standalone Modems, Maxwell Modem Series, MDS I System for Rack-Mount Modems, MDS II Advanced

Continued...............

Rack-Mount Modem System, and Multiplexers & Data Compressors (7400 series). In 1985 the firm introduced new modems with such features as AT dialing protocol, MNP error control, etc. Modem speeds up to 9600 bps are offered.

During the year the Data Communications group formed a new company, Racal Imaging Systems Ltd., to enter the optical disc-based document storage and retrieval market. This company has already supplied equipment to the British government, Prudential Assurance Co., and British Telecom.

TIMEPLEX, INC.

Timeplex is a leading manufacturer of high performance data communications equipment and a supplier of data communications systems. The company's products include: data multiplexors, network and facilities management systems, packet assemblers and disassemblers, and modems. Data multiplexors account for the bulk of sales. Foreign sales contributed 34% of total sales in fiscal 1986, and sales to U.S. Government agencies accounted for 5%.

Dun's Business Rankings reports that Timeplex employs 745 workers, 150 at its Woodcliff Lake, NJ facility. Dun's also reported that the company's sales were $66 million, lower than the figures reported by Standard & Poors in the table below.

The **Microplexor** line of statistical multiplexors is a major product line. The **Link** family of products, an important line of facilities management systems, integrates network management processing and time division multiplexing functions for the rapidly growing class of high-speed data transmission facilities known as T-1. Initial product shipments began in fiscal 1984.

Standard & Poors reported that sales for the quarter ended Sept. 30, 1986 increased 15%, year to year, while margins narrowed and pre-tax income fell 15%. No cash dividends have ever been paid. Following on the next page an analysis of the company's financial position since 1980.

Continued...........

	Sales ($ Mill.)	Net Income ($ Mill.)	Net Income As % Sales	Capital Expend. ($ Mill.)	Current Ratio	Return On Assets
1980*	$18	$1.41	7.9 %	$3.8	2.1	13.2 %
1981	30	1.74	5.7	3.7	4.9	6.7
1982**	32	1.76	5.5	7.8	4.7	5.0
1983	44	3.44	7.9	8.7	5.4	5.6
1984	66	5.67	8.6	7.9	7.1	6.1
1985	96	9.99+	10.4	20.4#	5.3	8.2
1986	119	9.56+	8.0	21.2#	4.2	7.2

* Reflects merger or acquisition ** Excl. discontinued operations
# Net of current year retirement & disposals
+ Reflects accounting change

UNIVERSAL DATA SYSTEMS (Motorola Subsidiary)

Universal Data Systems, part of Motorola's Information Systems Group and based in Huntsville, Alabama, operates district offices in 20 states and Ontario, Canada (AL, AZ, CA, CO, FL, GA, IL, MA, MD, MI, MO, MN, NC, NJ, NY, OH, WA, WI). The company offers a V.33 modem ($2,995) for private line point-to-point systems, a 14.4 A/B modem ($2,995), a statistical multiplexer ($3,995), and a time division multiplexer ($3,495). Its main **modem** lines include.......the 103, 201, 202, and 212 series, as well as the 208 A/B, 9600, and 9600 A/B.

UDS **multiplexers** available include time division (six-channel), integrated into a single package with a V.33 compatible 14.4 kbps modem. The 14.4 model offers alternate data rates of 12 kbps and 9.6 kbps (V.29). With the A/B version, users can switch between private line and dial-up communications at 14.4 kbps.

CHRONOLOGY OF NEW PRODUCT INTRODUCTIONS AND COMPANY DEVELOPMENTS

MODEMS & MULTIPLEXERS: 1986 & 1987

The following section presents a variety of new product and technology developments concerning modems and multiplexors, taking place from January 1986 to September 1987. Information was obtained from Electronics, Electronic News, and other trade publications.

SEPTEMBER 1987

FIBER-OPTIC MULTIPLEXER QUADRUPLES CHANNELS ON ONE DUPLEX CABLE -- Pilkington Communication Inc.'s model 3128 fiber-optic time-division multiplexer is said to quadruple the number of channels available over a duplex fiber-optic cable, by interfacing with four IBM 3174 or 3274 communications contollers instead of one. Each of the cluster controllers handles up to 32 terminals. The model 3128 handles cable faults by performing automatic rerouting and can distribute messages among the controllers, says the Simi Valley, CA firm. It also interfaces with the Telex 274 controller. It is priced at $2,650 and up.

AT & T ISDN CHIP REPLACES A BOARD-LEVEL PRODUCT, COSTS 75% LESS -- AT & T's newest addition to its integrated services digital network product line replaces a board-level product that requires far more space and costs at least 50-75% more than this single-chip solution. The T7252 interfaces a digital local switch, PBX, multiplexer, or concentrator to ISDN, an evolving system that will tie voice, data, and video signals into a single high-speed digital network. Another advantage the T7252 offers designers is versatility. While the board products had to be customized for each given switch, the T77252 is fully programmable, allowing it to be used with equipment from multiple vendors. The T7252 costs about $14.50 in 1,000-unit lots.

ADAC OFFERS MULTIPLEXER EXPANDERS -- ADAC Corp. of Woburn, MA introduced three 16-channel signal conditioning multiplexer expander modules said to provide 3-wire and 4-wire measurement, bridge completion and amplification for data acquisition and control purposes with a variety of devices. The new 4012CSEX, 4012BGEX and 4012AMEX modules are part of ADAC's 4000 series signal-conditioning system. Prices start at $1,000 per module. The new devices can be used with RTDs, strain gages, accelerometers, and other kinds of transducers.

Continued............

COMTEN EXITING MODEM, PRIVATE X.25 MARKET -- NCR's Comten subsidiary is getting out of the modem and private X.25 networking equipment markets. Comten said it stopped manufacture of modems in late August and will cease taking orders for units in inventory on Sept. 15. Comten said it was dropping the two lines to concetrate on its bread-and-butter IBM-compatible front-end communications processor market, where return on investment is higher than the modem and private X.25 areas. Comten promised to maintain its 5-year warranties on modems in the field. The firm's modem line consisted of four models marketed under the Commander trade name--models 7160-0100C, 7160-0200C, 7165-C, and 7166-C. Single-quantity prices ranged from $2,995 to $3,995. Comten introduced its first modems in March, 1983. Although no sales figures were available from the company, industry sources indicated that it was not a major factor in either market.

AUGUST 1987

LOCAL NETS CAN TRANSMIT UP TO 2400 FT. WITH EXAR TRANSCEIVER CHIP SET -- Local area networks using either a star or bus topology can triple their maximum transmission distance with Exar Corp.'s transceiver chip set, as far as 2,400 ft. for the star and 1,600 ft. for the bus. Designed to support Starlan controllers such as Intel's 82586 and 83588, the two-chip Exar set achieves its performance advantage by segregating appropriate functions on one bipolar analog chip and one CMOS digital chip, instead of opting for a bipolar single-chip solution. Exar, based in San Jose, CA, says that segregating the functions leads to line-reflective indexes two to three times lower than competing systems. The digital CMOS XRT82C516 contains Manchester encoding and decoding logic, clock and compare circuitry, collision detection, carrier sensing, and transmission control logic. The analog bipolar XRT82515 contains variable-gain and summing amplifiers, filters, level detectors, and phase comparator circuitry. As of August 20, each chip set cost $17 in 1,000-unit purchases.

NEW THOMAS & BETTS FIBER-OPTIC MODEM -- The RS-232-C fiber-optic modem links data communications equipment and data terminal equipment with fiber-optic cable. The new modem can accomodate duplex or glass fiber-optic cables and handle data rates up to 19.2 bps. In addition to transferring data in both directions, the modem also provides support for six contol/handshake lines. It can be powered directly through a

Continued..........

DB25-pin connector or external plug-in jack power supply and comes with either male or female contacts. The modems are priced at $54 in lots of 500, for glass fiber, and $36 in plastic.

JULY 1987

AT & T DATAPHONE II LINE ADDS 4 MODEMS -- AT & T of Morristown, NJ has added four modems to its Dataphone II series, including its first 9,600 bps dial-up modem for standard telephone lines, the 2296A. The firm also brought out its Dataphone II 48/96 Shared Diagnostic Unit (SDU) that enables modems to interface with the Dataphone II network system. The 2296A provides full-duplex, synchronous or asynchronous transmission at 4,800 and 9,600 bps over standard phone lines and conforms to the CCITT's V.32 standards. It can operate over 4-wire private-line networks. Pricing begins at $2,500. Another new entry, the Dataphone model 2192A, was said to be capable of full-duplex, synchronous data transmission over private-line channels at up to 19,200 bps and of automatically diagnosing faults anywhere in its connected network. It is priced at $9,500. The remaining two modems are different versions of the same unit. The 2224G can be mounted while the 2224CEO is a stand-alone modem. Both provide full-duplex communications, and operate synchronously at 300, 1,200, and 2,400 bps and asynchronously up to 2,400 bps. The 2224G costs $650 and the 2224CEO, $695. The Dataphone II 48/96 SDU lists for $625.

MICOM UNVEILS VOICE/DATA MULTIPLEXER -- Micom of Simi Valley, CA, entered the digital wideband market with the introduction of a 56K-bps integrated voice/data multiplexer, the Oneliner. It is the first Micom product that uses the firm's Advanced Packetized Voice Technology (APV), designed for users who want to integrate voice and data communications but whose systems are not large enough to use more expensive T1 rates and equipment. Voice transmission is possible at data rates of 9.6K bps instead of the standard rate of 64K. The Oneliner multiplexes multiple synchronous and asynchronous data channels and up to four 9.6K-bps voice channels over one 56K-bps digital circuit. Prices start at $4,635. The unit is the first of a series of voice packetization products it plans to introduce for the digital wideband market.

EMULEX 14.4-KBIT/S MODEM TO COST THE SAME AS 9.6-KBIT/S PRODUCTS -- Computer products specialist Emulex Corp. broke into the communications hardware market with a 14.4-Kbit/s

Continued..........

modem that offers a 50% performance advantage over the 9.6-Kbit/s modems now standard for leased-line transmissions. A proprietary CMOS six-chip set is the key factor bringing the Performance 1000 full-duplex modem in at $1,795--about the same price as the 9.6-Kbit/s modems, claims the Costa Mesa, CA company. The chip set also delivers a 50% reduction in component count, contributing to an 8.5-by-11-in. footprint for the 2.5-in.-high modem--the smallest available at 14.4 Kbits. The modem also features menu-driven operation monitored by a liquid-crystal display. The modem conforms to the CCITT V.33 standard. A 9.6-Kbit/s version conforming to the V.29 standard sells for $1,295.

GE/RCA SOLID STATE OFFERS QUAD TWO-INPUT MULTIPLEXERS -- Two quad two-input multiplexors, the CD54/74AC/ACT157 and CD54/74AC/ACT158, are being offered by GE/RCA Solid State, Somerville, NJ. Both are pin-, function- and performance-compatible with S, AS and FAST devices and are designed to replace bipolar ICs in bipolar and mixed bipolar/CMOS systems. The multiplexors select four bits of output data from two-input sources. Output logic levels of the AC/ACT157 types are non-inverted, while output logic levels of the AC/ACT158 devices are inverted. A select control input is provided, that determines which of the two inputs is gated through to the output. Propogation delay time from input to output is 4.3 ns for the AC157 and 3.8 ns for the AC158. Prices begin at 96 cents in quantities of 100. The devices operate over a supply voltage range of 1.5-5.5 Vdc. CD54AC/ACT units operate over the full military temperature range of -55 degrees C to 125 degrees C. The CD74AC/ACT versions are available in 16-lead DIPs (E-suffix) and 16-lead dual-in-line plastic surface-mount packages (M-suffix).

JUNE 1987

STANFORD TELECOM HAS PROBLEMS WITH MODEM SUBCONTRACT -- Stanford Telecommunications Inc. of Santa Clara, CA was experiencing difficulties in the final implementation of requirements for production of a modem for a U.S. government satellite communication system. It was having problems designing boards for the modem, which it is producing under a subcontract from Ford Aerospace & Coomunications. These problems contributed to lower first quarter earnings.

PARADYNE BREAKS INTO T-1 MULTIPLEXER MARKET -- Paradyne Corp. entered the T-1 multiplexer market by introducing a nodal processor, the 3230, which it is marketing under a 1985 OEM agreement with

Continued..............

Spectrum Digital Corp.. It provides circuit switching for high-speed digital facilities including North American T-1 or international networks. The 3230 supports 508 voice and data ports per node and eight non-blocking trunks at 1.544M bps, or up to six 2.048M-bps aggregates for international users. Synchronous channel speeds are from 1.2K bps to 2.141M bps, asynchronous speeds up to 19.2K bps. Voice is supported using pulse coded modulation at 64K bps. A starting configuration, consisting of a single-chassis package with 20 voice and data ports, is priced at about $30,000.

MAY 1987

NETWORK SOFTWARE ASSOCIATES UNVEILS MODEM -- Network Software of Laguna Hills, CA introduced an auto-dialing synchronous/asynchronous modem for IBM and compatible PCs. It is called the AdaptModem 201/212, and incorporates a built-in synchronous Data Link Control adapter. AdaptModem 201/212 plugs into any full-sized PC expansion slot. In synchronous mode, it functions as a Bell 201C modem at 2,400 bps. In asynchronous mode, it functions as a Bell 212 modem at 300 or 1,200 bps. The price is $995 for the board and ACC software. NSA's synchronous communications software packages are priced separately, starting at $195.

ROCKWELL UNVEILS 9,600-BPS MODEM -- Rockwell International of Newport Beach, CA released a synchronous 9,600 bps modem, the R96MD, designed for operation over the public switched phone network through line terminations provided by data access arrangement. It meets requirements specified in CCITT V.29, V.27 ter, T.30, T.4 and T.3. The R96MD can operate at speeds of 9,600, 7,200, 4,800, 2,400 and 300 bps, and can generate voice band tones up to 4,800 Hz with a resolution of 0.15 Hz and an accuracy of 0.01 percent. The modem includes programmable tone detection and dual/single tone generation, a two-wire half-duplex, and is TTL and CMOS-compatible. The modem is designed for use in group 2 and 3 facsimile machines.

EXAR'S 2,400-BAUD SET WORKS WITH MOST MICROCONTROLLERS -- Exar Corp. employed digital signal processing technology to develop a two-chip 2,400-bit/s modem that provides all of the functions required for operation under the Bell 212A or CCITT V.22bis standards. The XR-2400 modem is designed to operate at 300, 1,200, and 2,400 bits/s. The 40-pin XR-2401 incorporates the modulation/demodulation circuitry,

Continued............

as well as such functions as carrier detection, automatic gain control, timing recovery, adaptive equalization, carrier recovery, and tone generation. The XR-2402 can be used with virtually any commercially available microcontroller, says Jim Lange, applications engineering manager. It also carries an analog-to-digital converter, a digital-to-analog converter, a band-splitting filter, a programmable-gain amplifier, asynchronous-to-synchronous and synchronous-to-asynchronous converters, and a guard-tone generator. The chips are available in plastic and ceramic pakages. The XR-2401 costs $18 each and the XR-2402 is $12 each in 10,000 unit quantities.

SIERRA'S MODEM CHIP FITS BOTH PARALLEL & SERIES INTERFACES

-- Sierra Semiconductor Corp.'s 2,400-baud modem chip set gives designers flexibility that helps cut costs. Competitive chip sets use either an analog or digital signal processing solution that requires the use--and expense--of an additional microcontroller. Sierra has divided modem functions differently among the chips, allowing designers to couple an analog front-end SC11006 part with either of two microcontrollers--the SC11009 for parallel-bus interfaces or the SC11010 for RS-232-C serial transmission. Both controllers use a bit-slice core processor architecture for digital signal processing and an instruction set similar to Intel's 8096 but up to 2.3 times faster. The chips are fabricated in San Jose, CA, the company's process combining 3-um analog and 2-um digital CMOS. They were available in sample quantities in ROM-less versions that allow designers to construct their own firmware. The SC11006 costs $49 each; the SC11009 and SC11010, $40 each in 100-unit lots.

APRIL 1987

TELEBIT DESIGNS 2,400-BAUD MODEM FROM OFF-THE-SHELF PARTS

-- Telebit Corp., which shook up the dial-up modem market in 1985 with its 18-Kbaud Trailblazer modem, came out with a design for a 2,400-baud modem that can be built from off-the-shelf second-sourced parts. It uses a Texas Instruments 320CM10 digital signal processor, programmed in read-only memory with basic modem functions from Telbit's Trailblazer architecture. The modem supports CCITT V,22bis, 2,400-baud transmission as well as Bell 212A and Bell 103 (1,200 and 300-baud) operation. The other two chips are an Intel Corp. 80C51 microcontoller with source code for mask programming and an Oki Semiconductor 6950B analog front end. Together the three chips cost about $27, says the Cupertino, CA company.

Continued...........

The Telebit licensing fee is either a $200,000 one-time payment, which includes engineering support; or a $25,000 technology-transfer fee plus a $5/unit royalty.

MARCH 1987

ROCKWELL MODEM TRANSMITS FACSIMILE INFORMATION AT 14,400 BITS/S -- An asynchronous, half-duplex modem board from Rockwell International Corp., that handles facsimile transmissions at a 14,400-bit/s pace promises to boost throughput by 50% over existing 9,600-baud equipment operating under the CCITT V.29 facsimile standard. The R144HD can run over public phone lines as well as leased ones, according to the Irvine, CA company. The board will appeal to OEMs with applications in still-frame video telephone equipment, electronic publishing, and similar systems. In quantities of 1,000 the R144HD costs $140 each. Shipments began in April 1987.

FEBRUARY 1987

BURR-BROWN'S FIBER OPTIC MODEM EXTENDS RS-232 LINKS TO 3.5 km -- Burr-Brown Inc.'s high-speed fiber-optic modem outdistances the 50-ft limit of conventional metal cable for RS-232-C connections by a factor of about 300. The LDM80 supports 3.5-km connections and transmission rates up to 19.2-k baud. It can be used with most fiber-optic cable sizes and is completely powered by the host computer's RS-232-C port signals, eliminating the need for a separate power supply. Maximum connection length is achieved by using glass cable having a 100-um core and an attenuation of 4 dB/km. The 3.5-by-1.7-by-0.8-in. modem is small enough to mount on the back of a video display terminal. Price is $98.

JANUARY 1987

EMULEX MULTIPLEXER DOUBLES MICROVAX TERMINAL INTERFACES -- An asynchronous multiplexor from Emulux Corp. lets the Digital Equipment Corp. MicroVax II and other Q-bus systems interface with twice as many terminals as is possible with DEC's DHV11 asynchronous multiplexors--eight lines to the DHV11's four. The CS08's single-board configuration makes the increase possible by better utilizing the MicroVax's bus-interface slots, says the Costa Mesa, CA firm. The dual-width board makes possible RS-232-C connections to most existing asynchronous terminals. It costs $1,000 without modem control and $1,200 with modem control, and was to be available in mid-March 1987.

INTEL'S $35 CHIP SET HAS HAYES MODEM COMMANDS IN FIRMWARE -- Intel Corp. was offering samples of a 2,400-baud modem chip set it claimed will drop the resulting modem's retail price to less than $200. The 89024 set puts the Hayes commands in firmware and is priced at $35 in 25,000 unit quantities. It consists of the 89026 16-bit digital signal processor and the 89027 analog front end for signal filtering. For interfacing the set to IBM and compatible PCs, Intel has also come out with a universal receiver/transmitter, the 82050, which is billed as a replacement for National Semiconductor's 8250. The UART was priced at $4.50 in lots of 10,000. The modem chip set was to be in full production by the 2nd quarter of 1987, and will support the V.22bis standard. It includes a full set of RS-232-C and V.24 terminal interface signals. The MEK69024 evaluation kit--a fully functioning modem with extra area for breadboarding--is also available, for $395.

JULY 1986

ROCKWELL SHIPS SINGLE-CHIP FACSIMILE MODEM -- Rockwell International Corp.'s Semiconductor Products Division began shipping samples of a single-chip facsimile modem that transmits data over the public switched telephone network at 2,400 b/s. The R24MFX will cut the size and cost of facsimile equipment and could give a shot in the arm to the emerging market for personal FAXes. Optimized for use in compact Group 3 facsimile machines, the chip has two interfaces--a parallel microprocessor bus interface and an Rs-232-C serial port. In 1,000-piece lots, the R24MFX sells for $40 each. The Newport Beach, CA division was to begin volume shipments in August 1987.

JUNE 1986

FUJITSU U.S. ENTERS END-USER MODEM MARKET -- Fujitsu America, Inc., of San Jose, CA, in an expansion of its U.S.-based modem operations, said it will enter the end-user market for the first time and create a new modem R & D group at the firm's Palm Bay, FL facility. The first modem aimed at the non-OEM market was to be the L series, stand-alone devices in the 2,400-bps to 14.4Kbps range, said Charles W. Roedel, V.P. Data Communications. Mr Roedel indicated that they were in the process of signing up distributors, probably regionals, and that in the future Fujitsu plans to add other modem offerings to its non-OEM line. The L series is made in Japan, with some final assembly at the 50,000 square ft. Palm Bay facility where the new R & D group is being established. That group will be chartered to create core technology for modem products.

Continued......

MARCH 1986

JOINT EFFORT BY DIGITAL COMMUNICATIONS ASSOCIATES & TELEBIT PRODUCES 18 KB/S FAST DIAL-UP MODEM - A dial-up modem with instantaneous data-transmission speeds nearly twice that of existing 9.6-kb/s modems was under development between the two firms. The key to the 18-kb/s asynchronous modem, an enhanced version of a Digital Communications product dubbed Fastlink, is a design combining a multicarrier modulation scheme, digital signal processing, and new packet technologies. Along with current applications, such as microcomputer-to-mainframe links, file transfers, information-retrieval services, and electronic mail, new dial-up applications include high-resolution graphics capabilities, videotext, software distribution, and LAN gateways to public switched networks. Fastlink is also compatible with slower modems and many transmission standards, including Bell 103 for 300-b/s transmission, the CCITT V.22 and Bell 212A standards for 1.2-kb/s transmission, and the CCITT V.22 bis std. for 2.4-kb/s transmission.

JANUARY 1986

MODEM MAKES IT EASIER TO TRANSMIT DATA OVERSEAS -- A modem module from Micro Power Systems Inc. will ease international data transmission. The MP212AT not only operates in the full-duplex 300- and 1,200-bits-per-second transmission standards of the U.S., but it also supports the ITTCC V.22 A, V.22 B, and V.21 standards widely used in Europe, Japan, and other nations. The modem module is housed on a single pc board that measures 3 X 4 by 0.4 in. Samples were to be available from the Santa Clara, CA company in January 1986. In large quantities, the modem sells for $110 each.

MISCELLANEOUS 1987 MARKET DEVELOPMENTS - MODEMS & MULTIPLEXERS

Following is a 1987 chronology of market developments, including new product announcements, joint company ventures, contract awards, etc. This information is separate from the "Chronology Of New Product Introductions" section; there is no duplication of material. The name of the trade journal publishing the article, and the page number it appears on, are listed for further reference.

3/23/87 AMERICAN TELEPHONE & TELEGRAPGH IS DISTRIBUTING ITS 90 MBps DDM MULTIPLEXER THROUGH ANIXTER BROTHERS (Fiber Optics, p. 7).

3/23/87 RAPIDTECH SYSTEMS BUYS ALL RIGHTS TO POCKET MODEM PATENT FROM INVENTOR (Computerworld, p. 104).

4/11/87 AT & T JOINTLY DEVELOPS COMPACT VOICE/DATA MULTIPLEX EQUIPMENT WITH NTT (Japan Economic Jrl. p. 12).

4/13/87 M/A COM GETS CONTRACT FOR ITS 4046 MODEM FROM SATELLITE TRANSMISSION SYSTEMS (Satellite News, p. 8).

4/21/87 PRACTICAL PERIPHERALS INTRODUCES POCKET-SIZED 1200 BPS MODEM (PC Week, p. 23).

4/28/87 TELEBIT WILL LICENSE NEW 2400 BPS MODEM DESIGN, BASED ON 3 CMOS CHIPS (PC Week, p. 29).

4/29/87 DEVELCON HAS SINGLE CARD STATISTICAL MULTIPLEXER FOR ITS NETWORKING DATA PBX (Data Channels, p. 7).

5/6/87 DYNATECH HAS NEW NETWORK CONTROLLER THAT ROUTES DATA & VOICE FROM T-1 TO 2.4 Kbps LEVEL (Data Channels, p. 7).

5/11/87 PARADYNE GETS $1.5 MILLION AWARD FROM VAN WATERS & ROGERS FOR DATA COMMUNICATIONS NETWORK (Electronic Engineering Times, p. 34).

5/18/87 ADVANCED TRANSDUCER DEVICES WILL OFFER 1200 BPS HAYES-COMPATIBLE MODEM FOR IBM PS/2 AND PC LINES (Info World, p. 6).

5/25/87 IBM TO MARKET NETWORK EQUIP. TECHNOLOGIES' IDNX MULTIPLEXER (MIS Week, P. 1).

Continued.............

6/87 DATATEL UNVEILS DCP9800 T-1 NETWORK SWITCH (Satellite, p. 49).

6/8/87 NETWORK EQUIP. TECHNOLOGIES' NEW INTEGRATED DIGITAL NETWORK EXCHANGE/20 HANDLES UP TO 8 T-1 CIRCUITS (MIS Week, p. 25).

6/9/87 DATA RACE WILL EXCHANGE HIGH-SPEED MODEM TECHNOLOGY WITH U.S. ROBOTICS (PC Week, p. C3).

6/15/87 PARADYNE IS OEMing SPECTRUM DIGITAL'S 3230 T-1 MULTIPLEXER (MIS Week, p. 31).

MODEMS PRODUCT LINE COMPARISON, BY COMPANY (APPLICATIONS, FEATURES, TECHNOLOGIES)

The following is a summary and comparison of some of the more well-known modem product lines by major manufacturers in the market. It is by no means an all-inclusive listing, but will give the reader a good understanding of the most common capabilities, applications, features and technical aspects related to modems.

CODEX 2260

The Codex 2260 supports full-duplex 9600 bps operation and falls back to 4800 bps. The modem has several features consistent with its orientation toward large-scale data communications applications: a leased-line phone connection jack, an internal phone book that stores up to nine telephone numbers, password protection, and line-quality monitoring capabilities via an externally connected oscilloscope. Like the Racal modem, the Codex 2260 has a drop-down front panel that conceals a five-key keypad. The Codex modem supports th Hayes AT command set as well as its own Codex Verbose command set.

FASTCOMM 2496

The Fastcomm 2496 is an asynchronous half-duplex 9600 bps modem capable of communicating at 300, 1200, or 2400 bps as well as using a proprietary adaptation of V.29. It has an error correction technique, a hardware-based CRC-16 implementation that uses selective retransmission. It can switch a remote modem to the highest mutually acceptable data rate. However, it is one of the few modems that does not have a jack for attaching the telephone to the modem, allowing for voice calls to be received when the modem is not in operation.

HAYES SMARTMODEM 2400

The Smartmodem series sets the standard among intelligent modems. It supports 300 and 1200 bps predecessors. It has several commands such as for controlling speaker volume, and the selection of synchronous and asynchronous modes. In the future, Hayes will use a version of the CCITT X.25 packet-switching protocol to provide error correction at 2400 bps.

MICROCOM AX/9624c

The Microcom AX/9624c is a 9600 bps modified V.29 modem that can also operate at 2400, 1200, and 300 bps. It incorporates MNP class 5, a data compression algorithm currently available only on Microcom modems. Effective throughput can be dramatically increased, to an average of 14,000 bps. The Microcom modem is limited to half-duplex operation at high speed, and there is no on/off switch. It uses a proprietary SX command set as well as the Hayes AT complement.

MIGENT POCKET MODEM

The Migent 1200 bps modem is either battery or AC-powered, and is about the size and weight of a TV remote control, making it very convenient. It is Hayes compatible and has no hardware switches to set or configuration routines to run. Configuration settings and one phone number and access code can be stored in nonvolatile memory. Error correction is accomplished via the communications software. It is priced at $249, very economical and appropriate if you don't anticipate making large-volume data transfers and can get by with 1200 bps.

NOVATION PROFESSIONAL 2400

The Novation 2400 is a 2400 bps Hayes-compatible modem with advantages in the options available: versions that include MNP error correction and password and callback security features. Novation also has LCD displays, and the modem, when turned on, will automatically perform a six-step self-test with audible musical feedback.

RACAL-VADIC 9600 VP

Racal's 9600 bps modem uses a proprietary techniques to adapt V.29 technology. The dynamic duplex protocol allows full-duplex operation when interactive asynchronous data is being transmitted, and switches to a half-duplex link for high speed transfers. The front panel features a nine-LED status indicator panel, along with a ten-key keypad from which commands (such as phone numbers for dialing) can be entered. Modem commands can be issued using either the Vadic or Hayes AT command set. As with the Microcom modem, there is no on/off switch: the modem must be unplugged to be turned off. Error correction is provided using a superset of MNP class 3. In addition, the modem automatically adjusts transmission speed to balance error rates and data throughput. When errors occur the modem falls back from 9600 bps to 4800, 2400, or 1200 bps, until the lowest error rate is achieved.

TELCOR ACCELERATOR

The Telcor (formerly Telebyte) Accelerator is a full-duplex 2400-baud modem that achieves 9600 bps using a data compression technique. Throughput varies from 6500-9600 bps. Telcor's error correction scheme is a proprietary implementation of a CRC-16 protocol, with the firm planning to release a version that incorporates MNP class 3. Telcor's acceleration can be turned off so that the modem also supports communication at 300 and 1200 bps.

TELEBIT TRAILBLAZER

This modem can transmit and receive data asynchronously at speeds up to 18,000 bps, using a proprietary transmission and error-correcting protocol appropriately named PEP (Packetized Ensemble Protocol). The Trailblazer is also compatible with 300, 1200, and 2400 bps modems and will automatically shift to match the transmission speed of the remote modem during the initial "handshake". Trailblazer can transfer data using Microcom's MNP protocol. Telebit has also added the Kermit and Xmodem protocols. Like the Racal modem, Telebit uses an adaptive duplex technique. It is Hayes compatible, and a CRC-16 protocol with selective transmission is used to ensure that data is received error-free.

COMPETITOR LISTS - MODEMS & MULTIPLEXORS

The following section lists the major manufacturers/suppliers of various types of modems and multiplexors, compiled from a recent issue of the Electronic Design Gold Book and Thomas Register. From the Gold Book, Marketdata has identified at least 100 modem makers, and an additional 89 producers of multiplexors--for a combined total of at least 189 manufacturers competing for modem & multiplexor sales. A significant number of modem makers (27%--33 of 122 companies listed) **also** make multiplexors--no surprise, since the two products are closely related and part of the overall "data communications" market.

The company's name and address are provided in this section, with an additional product key that identifies **what type** of modem or multiplexor the company makes. **Modems** can be classified as follows..............

Acoustically Coupled
Asynchronous
Digital
Fiber Optic
Frequency Shift Keyed
Integrated Circuit
Limited Distance
Long Haul
Short Haul
Synchronous
Voice Grade

Multiplexors can be classified as....................

Analog
Concentrator
Digital
Frequency Division
Low-Level
Microwave
Radio
Time Division
Transmission
Video
Wireline

MODEM MANUFACTURERS

KEY:
A = NOT LISTED ELSEWHERE
B = ACCOUSTICALLY COUPLED
C = ASYNCHRONOUS
D = FREQUENCY SHIFT KEYED
E = SYNCHRONOUS

Advanced Micro Devices Inc.
901 Thompson Place MS 145, Sunnyvale, CA 94088 (D)
Amdahl Corporation
Coms Systems 2500 Walnut Avenue, Marina del Rey, CA 90291 (A)
Artel Coms. Corp.
Box 100 West Side Station, Worcester, MA 01602 (E)
Astocom Corporation
120 W. Plato Blvd., St. Paul, MN 55107 (A)
Aydin Microwave
75 E. Trimble Road, San Jose, CA 95131 (D)
Aydin Monitor Systems
Aydin Corporation 502 Office Center Drive, Ft. Washington, PA 19034 (D)
BO-Sherrel Co., Inc.
36133 Niles Blvd., Freemont, CA 94536 (A)
Betatronics Inc.
9323 Lincolnwood Avenue, Evanston, IL 60203 (A)
Bizcomp Corporation
632 Mercury Drive, Sunnyvale, CA 94086 (A)
CTS Knights
CTS Electronic Product Group 400 Reimann Avenue, Sandwich, IL 60548 (D)
Cermetek Microelectronics
1308 Borregas Avenue, Sunnyvale, CA 94086 (A)
Cetec Vega
9900 Baldwin Place, El Monte, CA 91731 (A)
Codenoll Technology Corp.
1086 N. Broadway, Yonkers, NY 10701 (E)
Codex Corp
20 Cabot Blvd., Mansfield, MA 02048 (A)
Coherent Coms. Systems Corp.
60 Commerce Drive, Hauppauge, NY 11788 (C)
ComData Corp.
7900 N. Nagle Avenue, Morton Grove, IL 60053 (A)
ComDesign Inc.
751 S. Kellogg Avenue, Goleta, CA 93117 (C)
Complexx Systems Inc.
4930 Research Drive, Huntsville, AL 35805 (E)
Computrol
Kidde Automated Systems Inc. 15 Ethan Allen Hwy., Ridgefield, CT 06877 (A)
Comtech Data Corp.
350 N. Hayden Road, Scottsdale, AZ 85257 (A)
Concord Data Systems
303 Bear Hill Road, Waltham, MA 02154 (A)
Coosol Inc.
Computer Baron 3013 Harbor Blvd., Costa Mesa, CA 92626 (C)

MODEM MANUFACTURERS

Da-Tel Research Co., Inc.
PO Box 1206, Montrose, CO 81402 (A)
Dantel Inc.
2991 N. Argyle Avenue, Fresno, CA 93727 (D)
Data Rental/Sales Inc.
8611 Hayden Place, Culver City, CA 90230 (A)
Data-Control Systems
Div. of Quanta Systems 1455 Research Blvd., Rockville, MD 20850 (A-E)
Datacom Northwest Inc.
S. Complex Building 100 3003 112th Street, S.W., Everett, WA 98204 (C)
Datagram Corp.
11 Main Street, E. Greenwich, RI 02818 (A)
Dataprobe Inc.
110 W. Palisades Blvd., Palisades Park, NJ 07650 (D)
Datec Inc.
200 Eastowne Drive, Ste. 116, Chapel Hill, NC 27514 (A)
Decom Systems Inc.
340 Rancheros Drive, San Marcos, CA 92069 (A)
Digital Matrix Corp.
105 Filley Street, Bloomfield, CT 06002 (B)
Dynamic Measurements Corp.
8 Lowell Avenue, Winchester, MA 01890 (C)
Dynatech Corp.
Dynatech Data Systems 7644 Dynatech Ct., Springfield, VA 22153 (E)
Electronics Warehouse Inc.
Box 624, Old Lyme, CT 06371 (A)
Entpr. Sys. Corp.
Box 698, Dover, NH 03820 (D)
Exar Integrated Systems, Inc.
750 Palomar Avenue PO Box 3575, Sunnyvale, CA 94088 (A)
FG Engineering Co.
Box 476 Highway 89A, Fredonia, AZ 86022 (A)
Fibronics Intl. Inc.
325 Stevens Street, Hyannis, MA 02601 (A)
GTE Corporation
GTE Sys. Coms. Sys. Division 77 A Street, Needham Heights, MA 02194 (A)
Gandalf Data Inc.
1019 S. Noel, Wheeling, IL 60090 (A)
Genelex Inc.
64 Gough Avenue, Ivyland, PA 18974 (A)
General Data Com. Ind. Inc.
One Kennedy Avenue, Danbury, CT 06810 (A)
HAL Coms. Corp.
PO Box 365, Urbana, IL 91801 (D)
Halcyon
2121 Zanker Road, San Jose, CA 95131 (E)
Harris Corp.
RF Coms. Group 1680 University Avenue, Rochester, NY 14610 (D)
Harvey Hubbell Inc.
Pulsecom Div. 2900 Towerview Road, Herndon, VA 22071 (D)
Hayes Microcomputer Products Inc.
5923 Peachtree Indl. Blvd., Norcross, GA 30092 (A)

MODEM MANUFACTURERS

Hughes Aircraft Co.
    Corporate Marketing PO Box 1053, El Segundo, CA 90245 (A)
Hycom Inc.
    16841 Armstrong Avenue, Irvine, CA 92714 (A)
Infotron Systems Corp.
    9 N. Olney Avenue, Cherry Hill, NJ 08003 (A)
Inmac
    2465 Augustine Drive, Santa Clara, CA 95051 (B)
International Data Sciences Inc.
    7 Wellington Road, Lincoln, RI 02865 (A)
Intertel Inc.
    6 Shattuck Road, Andover, MA 01810 (A)
Kinex Corp.,
    Nokia Inc. 6950 Bryan Dairy Road, Largo, FL 33543 (A)
Leaming Inds.
    180 McCormick Avenue, Costa Mesa, CA 92626 (A)
M/A-COM DCC Inc.
    11717 Exploration Lane, Germantown, MD 20874 (A)
MICOM Systems Inc.
    20151 Nordhoff Street, Chatsworth, CA 91311 (A)
Madzar Corp.
    37490 Glenmoor Drive, Fremont, CA 94536 (A)
Manage Inc., Electro-Optics
    PO Box 175 40 Nichols Road, Chicopee, MA 01014 (A)
Micro-Baud Systems Inc.
    3393 De La Cruz Blvd., Santa Clara, CA 95050 (A)
Micro-Link Corp
    14602 North U.S. Hwy 31, Carmel, IN 46060 (A)
Misco Inc.
    Somputer Supplies One Misco Plaza, Holmdel, NJ 07733 (B)
Morrow
    600 McCormick Street, San Leandro, CA 94577 (A)
Multi-Tech Systems Inc.
    82 Second Avenue, S.E., New Brighton, MN 55112 (A)
NCR Omten Inc.
    NCR Corporation 2700 Snelling Avenue N., St. Paul, MN 55113 (E)
NU Data Corp.
    32 Fairview Avenue, Little Silver, NJ 07739 (D)
Novation Inc.
    20409 Prairie Street, Chatsworth, CA 91311 (A)
Optical Data Systems
    1226 Exhange Drive, Richardson, TX 75081 (C)
Penril DataComm
    Div. of Penril Corp. 207 Perry Pkwy., Gaithersburg, MD 20877 (A)
Perkins Research & Mfg. Co.
    Canoga Data Systems 21218 Vanowen Street, Canoga Park, CA 91303 (E)
Plantronics/Frederick Elecs. Corp.
    7630 Hayward Road, Frederick, MD 21701 (D)
Prentice Corp.
    266 Caspian Drive PO 3544, Sunnyvale, CA 94088 (A)
RFL Ind. Inc.
    Coms. Div. Powerville Road, Boonton, NJ 07005 (D)

MODEM MANUFACTURERS

Racal-Vadic
1525 McCarthy Blvd., Milpitas, CA 95035 (A)
Raven Electronics Corp.
400 Wolverine Way, Sparks, NV 89431 (C)
Rockwell Intl Corp.
Commercial Elecs. Ops. 1200 N. Alma Road, Richardson, TX 75081 (D)
SCI Systems Inc.
8600 S. Memorial Parkway PO Box 4000, Huntsville, AL 35802 (D)
Seaboard Electronics Co.
Seaboard Inds. Inc. 70 Church Street, New Rochelle, NY 10805 (D)
Shaffstall Corp., Penta Systems International
7901 E. 88th Street, PO 50990, Indianapolis, IN 46250 (C)
Signatron Inc.
Dept. M 12 Hartwell Avenue, Lexington, MA 02173 (A)
Sonex Corp.
931-939 E. Lycoming Street, Philadelphia, PA 19124 (D)
TM Systems Inc.
25 Allen Street, Bridgeport, CT 06604 (A)
Tech Magic Inc.
17742 Mitchell, N. Irvine, CA 92714 (C)
Tele-Signal Corp.
185 Oser Avenue, Hauppauge, NY 11788 (D)
Telebyte Tech Inc.
148 New York Avenue, Halesite, NY 11743 (A)
Telecom Terminal Systems
621 Hindry Avenue, Inglewood, CA 90301 (D)
Teleprinter Corp.
550 Springfield Avenue, Berkeley Heights, NJ 07922 (A)
Teltone Corp.
Telcom Components 10801 120th Avenue, N.E., Kirkland, WA 98033 (A)
Terminal Data Corp.
15733 Crabbs Branch Way, Rockville, MD 20855 (C)
Time Zero Corp.
103 Central Avenue, Clifton, NJ 07011 (A)
Timeplex Inc.
400 Chestnut Ridge Road, Woodcliff Lake, NJ 07675 (D)
Tuck Data Coms. Inc.
Tuck Elecs. Inc. 330 Second Street, New Cumberland, PA 17070 (A)
US Robotics Inc.
1123 W. Washington Blvd., Chicago, IL 60607 (A)
Ungermann-Bass Inc.
2560 Mission College Blvd., Santa Clara, CA 95050 (E)
Universal Data Systems, Inc.
Motorola Inc. 5000 Bradford Drive, Huntsville, AL 35805 (A)
Ven-Tel Inc.
2342 Walsh Avenue, Santa Clara, CA 95051 (C)
Zeta Labs Inc.
3265 Scott Blvd., Santa Clara, CA 95051 (A)
Zoom Telephonics
207 South Street, Boston, MA 02111 (D)

MULTIPLEXER MANUFACTURERS

KEY:
1 = ANALOG
2 = DIGITAL
3 = FREQUENCY DIVISION
4 = LOW-LEVEL
5 = MICROWAVE
6 = RADIO
7 = TIME DIVISION
8 = TRANSMISSION
9 = VIDEO
10 = WIRELINE CONCENTRATORS

AD Data Systems Inc.
200 Commerce Drive, Rochester, NY 14623 (1)
AUL Instruments Inc.
1055 Stewart Avenue, Garden City, NY 11530 (1)
Acromag Inc.
30765 Wixom Road, Wixom, MI 48096 (1)
Action Instruments Co., Inc.
8601 Aero Drive, San Diego, CA 92123 (1)
Advanced System Concepts
435 Lake Avenue, Pasadena, CA 91101 (2)
Amecom Div.
Litton Systems Inc. 5115 Calvert Road, College Park, MD 20740 (6)
Analog Devices Inc.
2 Technology Way, Norwood, MA 02062 (1)
Analog Precision Inc.
1620 N. Park Avenue, Tucson, AZ 85719 (1)
Analogic Corp.
Data Conversion Div. Audubon Road, Wakefield, MA 01880 (1)
Analogic Corp.
Industrial Technology 14 Electronics Avenue, Danvers, MA 01923 (1)
Anaren Microwave Inc.
PO Box 178 6635 Kirkville Road, E. Syracuse, NY 13057 (5)
Applied Research Inc.
160 Dupont Street, Plainview, NY 11803 (3)
Aydin Monitor Systems
Aydin Corporation 502 Office Center Drive, Ft. Washington, PA 19034 (1)
Aydin Vector Div.
PO Box 328, Newtown, PA 18940 (1)
Belden Electric Wire & Cable
PO Box 1980, Richmond, IN 47374 (2)
Buhl Optical Co.
1009 Beech Avenue, Pittsburgh, PA 15233 (9)
Burr-Brown Corp.
PO Box 11400, Tucson, AZ 85734 (1)
Cardion Electronics
Coms. Dept. 895 Waverly Avenue, Holtsville, NY 11742 (1)
Catel Telecommunications
4800 Patrick Henry Drive, Santa Clara, CA 95054 (6)
Cetec Vega
9900 Baldwin Place, El Monte, CA 91731 (4)
Cincinnati Electrosystems Inc.
469 Wards Corner Road, Loveland, OH 45140 (2)
Cirqtel Inc.
10504 Wheatley Street, Kensington, MD 20895 (5)

MULTIPLEXER MANUFACTURERS

Coastcoem
2312 Stanwell Drive, Concord, CA 94520 (1)
Colorado Data Systems Inc.
3301 W. Hampden Avenue, Englewood, CO 80110 (1)
Colorado Video Inc.
PO Box 928, Boulder, CO 80306 (9)
Control Module Inc.
380 Enfield St., Enfield, CT 06082 (2)
Cutler-Hammer Products
Eaton Corporation 4201 N. 27th St., Milwaukee, WI 53216 (1)
Cytec Corp
107 N. Washington Street, E. Rochester, NY 14445 (1)
Data Translation Inc.
100 Locke Drive, Marlboro, MA 01752 (1)
Data-Control Systems
Div. of Quanta Systems 1455 Research Blvd., Rockville, MD 20850 (1)
Datacap Inc.
11558 Sorrento Valley Road Building #5, San Diego, CA 92121 (2)
Datawest Corp
7333 E. Helm Drive, Scottsdale, AZ 85260 (1)
Data General Corp.
4400 Computer Drive, Westboro, MA 01580 (2)
Decom Systems Inc.
340 Rancheros Drive, San Marcos, CA 92069 (2)
Delta Microwave Inc.
840 Via Alondra, Camarillo, CA 93010 (5)
Dielectric Coms.
Tower Road, Raymond, ME 04071 (8)
Dynamic Sales of New England
97 Cambridge Street, Burlington, MA 01803 (1)
Dynamics
Div. of Waugh Controls 9001 Fullbright Avenue, Chatsworth, CA 91311 (1)
E&L Instruments
Interplex Electronics Co. 70 Fulton Terrace, Box 1942, New Haven, CT 06509 (1)
E-Systems Inc.
Corporate Headquarters PO Box 226030, Dallas, TX 75266 (2)
Electromatic Comp. Ltd.
1531 Burgundy Parkway, Streamwood, IL 60103 (10)
Electronics Warehouse Inc.
Box 624, Old Lyme, CT 06371 (2)
Emerson Electric Co.
Doric Scientific Div. 3883 Ruffin Road, San Diego, CA 92123 (2)
Fairchild Camera & Instrument Corp.
Digital Prods. Div. 333 Western Avenue S., Portland, ME 04106 (2)
Fairchild Weston Systems Inc.
Data Systems (EMR) PO Box 3041, Sarasota, FL 33578 (1)
Fibronics International Inc.
325 Stevens Street, Hyannis, MA 02601 (2)
Futronix Inc.
PO Box 2269, Sunnyvale, CA 94087 (2)
GE Datel
11 Cabot Blvd., Mansfield, MA 02048 (1)

MULTIPLEXER MANUFACTURERS

GEN/COMP Inc.
6 Algonquin Road, Canton, MA 02021 (7)
Gamma-F Corp.
3111 Fujita Street, Torrance, CA 90505 (5)
Global Specialties, Interplex Electronics Inc.
70 Fulton Terrace, PO Box 1942, New Haven, CT 06509 (1)
HERCO
PO Box 3246, Houston, TX 77001 (1)
Hughes Aircraft Co.
Corporate Marketing PO Box 1053, El Segundo, CA 90245 (1)
Hybrid Systems Corporation
Marketing 22 Linnell Circle, Billerica, MA 01821 (1)
IPAC Group Inc.
3047 Industiral Blvd., Bethel Park, PA 15102 (1)
Information Transfer Indl. Inc.
PO Box 357, Holcomb, NY 14469 (1)
Infotron Systems Corp.
9 N. Olney Avenue, Cherry Hill, NJ 08003 (1)
Intech Inc.
Microcircuits 2270 Martin Avenue, Santa Clara, CA 95050 (1)
Interface Engineering Inc.
386 Lindelof Avenue, Stoughton, MA 02072 (1)
Intermec Corp.
PO Box 360602, Lynnwood, WA 98046 (2)
Javelin Electronics Inc.
19831 Magellan Drive, Torrance, CA 90502 (9)
K & L Microwave Inc.
408 Coles Circle, Salisbury, MD 21801 (3)
KW Engineering Inc.
4565 Ruffner Street, San Diego, CA 92111 (5)
Karkar Electronics Inc.
245 11 Street, San Francisco, CA 94103 (2)
Keithley Instruments Inc.
28775 Aurora Road, Cleveland, OH 44139 (1)
Kinetic Systems Corp.
11 Maryknoll Drive, Lockport, IL 60441 (1)
LDV Electro Science Ind. Inc.
2027 Teall Avenue, Syracuse, NY 13206 (5)
Lark Engineering Co. Inc.
26401 Calle Rolando, San Juan Capistrano, CA 92675 (5)
Larse Corp.
4600 Patrick Henry Drive, Santa Clara, CA 95050 (2)
Leaming Industires
180 McCormick Avenue, Costa Mesa, CA 92626 (1)
Lightwave Coms. Inc.
650 Danbury Road, Ridgefield, CT 06877 (1)
Loral Terracom
Loral Corp. 9020 Balboa Avenue, San Diego, CA 92123 (2)
Lorch Electronics Corp.
105 Cedar Lane, Englewood, NJ 07631 (5)
Magnum Microwave Corp.
365 Ravendale Drive, Mountain View, CA 94043 (2)
Manage Inc.
Electro-Optics PO Box 175, 40 Nichols Rd., Chicopee, MA 01014 (7)

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Marlee Switch Co.
933-D N. Central Avenue, Upland, CA 91786 (5)
Matrix Corp.
2260 Distributors Drive, Indianapolis, IN 46241 (2)
McDonnell Douglas Electronics
Box 426, St. Charles, MO 63302 (2)
Megadata Corp.
35 Orville Drive, Bohemia, NY 11716 (8)
Mepcom International Inc.
PO Box 610719, Dallas, TX 75261 (2)
Micro Coms Inc.
438 Kelley Avenue PO Box 4365, Manchester, NH 03108 (5)
Microphase Corp.
587 Connecticut Avenue, Norwalk, CT 06880 (5)
Moseley Assocs. Inc.
111 Castilian Drive, Goleta, CA 93117 (8)
Motorola Coms. & Elecs. Inc.
1301 E. Algonquin Road, Schaumburg, IL 60196 (5)
Mu-Del Electronics Inc.
2426 Linden Lane, Silver Spring, MD 20910 (5)
Narda Microwave Corp.
435 Moreland Road, Hauppauge, NY 11788 (5)
National Semiconductor Corp.
2900 Semiconductor Drive, Santa Clara, CA 95051 (1)
North Hills Electronics Inc.
Alexander Place, Glen Cove, NY 11542 (3)
Omega Engineering Inc.
1 Omega Drive, Stamford, CT 06907 (1)
Opto 22
15461 Springdale Street, Huntington Beach, CA 92649 (1)
P & H Labs
4496 Runway Street PO Box 1800, Simi Valley, CA 93062 (5)
Phoenix Data Inc.
3384 W. Osborn Road, Phoenix, AZ 85017 (1)
Point 4 Data Corp.
2569 McCabe Way, Irvine, CA 92714 (10)
Precision Digital Corp.
80 Coolidge Hill Road, Watertown, MA 02172 (1)
Premier Microwave Corp.
33 New Broad Street, Port Chester, NY 10573 (5)
Preston Scientific
805 E. Cerritos Avenue, Anaheim, CA 92805 (1)
RYT Ind. Inc.
336 Mathew Street, Santa Clara, CA 95050 (5)
Rochester Instrument Systems Inc.
255 N. Union Street, Rochester, NY 14605 (1)
Ronan Engineering Co.
21200 Oxnard Street, Woodland Hills, CA 91367 (2)
SCI Systems Inc.
8600 S. Memorial Pkwy PO Box 4000, Huntsville, AL 35802 (1)
Sage Labs Inc.
3 Huron Drive, Natick, MA 01760 (5)
Scanivalve Corp.
PO Box 20005, San Diego, CA 92120 (1)

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2908 National Drive, Garland, TX 75041 (5)
Seiscor Technologies
5311 S. 122 E. Avenue PO Box 470580, Tulsa, OK 74147 (1)
Sercel Inc.
17155 Park Row PO Box 218909, Houston, TX 77218 (8)
Serial Lab Prods. Inc.
162 Cook Lane PO Box 766, Marlboro, MA 01752 (1)
Signetics Corp.
U.S. Philips Corp. 811 E. Arques Avenue, PO Box 3409, Sunnyvale, CA 94088 (2)
Siliconix Inc.
2201 Laurelwood Road, Santa Clara, CA 95054 (1)
Singer Co.
Kearfott Div. 1150 McBride Avenue, Little Falls, NJ 07424 (2)
Solid State Electronics
18646 Parthenia Street, Northridge, CA 91324 (8)
Sonex Corp.
931-939 E. Lycoming Street, Philadelphia, PA 19124 (1)
Sprengnether Instruments
Dyneer Corp. 4150 LaClede Avenue, St. Louis, MO 63108 (1)
Standard Engineering
44800 Industrial Drive Dept. O, Fremont, CA 94538 (1)
Tau-Tron Inc.
Unit of General Signal 10 Lyberty Way, Westford, MA 01886 (2)
Tech Research & Mfg. Inc.
Grenier Field RFD #10, Manchester, NH 03103 (5)
Teledyne Crystalonics
147 Sherman Street, Cambridge, MA 02140 (2)
Telonic/Berkeley Inc.
2925 Laguna Canyon Road PO Box 277, Laguna Beach, CA 92652 (5)
Tennelec Inc.
601 Oak Ridge Tpke., Oak Ridge, TN 37830 (1)
Texas Instruments Inc.
Semiconductor Group PO Box 225012 M/S 57, Dallas, TX 75265 (2)
Transmagnetics Inc.
210 Adams Blvd., Farmingdale, NY 11735 (1)
Transmation Inc.
PO Box 7803, Rochester, NY 14606 (1)
Universal Data Systems
5000 Bradford Drive, Huntsville, AL 35805 (1)
Wavecom
Loral Corp. 9036 Winnetka Avenue, Northridge, CA 91324 (5)
West Coast Research Corp.
Transducer Technology Specs. PO Box 25061, Los Angeles, CA 90025 (1)
Zeltex Inc.
940 Detroit Avenue, Concord, CA 94518 (1)